TECHNOLOGICAL HANDBOOKS.

EDITED BY

SIR H. TRUEMAN WOOD.

COACHBUILDING

TECHNOLOGICAL HANDBOOKS.

THE ART AND CRAFT

OF

COACHBUILDING

BY

JOHN PHILIPSON, M.Inst.M.E.

PAST PRESIDENT INSTITUTE BRITISH CARRIAGE MANUFACTURERS; MEMBER OF THE COACHMAKERS' AND COACH HARNESS MAKERS' COMPANY, LONDON; THE SOCIETY OF ARTS AND THE CARRIAGE BUILDERS' NATIONAL ASSOCIATION, U.S.A., ETC.

LONDON

GEORGE BELL AND SONS

1897

CHISWICK PRESS:—CHARLES WHITTINGHAM AND CO.
TOOKS COURT, CHANCERY LANE, LONDON.

PREFACE.

WHEN the Editor of this series asked me to prepare a text-book on "Road-carriage building," his request, no doubt, arose from the fact that during the last twenty-six years I have taken an active interest in the technical education of those engaged in the industry.

I hesitated to undertake the responsibility, partly because the calls upon my time leave few opportunities for such work; and also because I felt that there were others who could have accomplished the task much more efficiently than myself. It was, however, pointed out to me that a practical experience of forty-five years as a carriage manufacturer justified me in accepting the Editor's proposal. The recommendations of friends whose opinions I esteem, a desire to do something useful towards the establishment of an efficient system of technical education, and the fact that Mr. Geo. N. Hooper, who is deservedly regarded as the main pillar of our industry, was willing to read and revise the proofs, removed the doubts which existed in my mind. It would be absurd to pretend that such a book as this is either perfect or original, but I have been gratified to find that my ideas have very closely accorded with Mr. Hooper's judgment, and I sincerely thank him for many valuable suggestions.

A wish to be correct caused me to ask Mr. S. C. L. Fuller, of Bath, and Mr. William Gilchrist, of Lancaster, also to read the proofs, and to give me the advantage of their knowledge of technical terms as employed in other parts of the

Kingdom than the north. Both gentlemen have generously placed their experience at my disposal, and have materially contributed to any value which this book may possess. Great help has also been given by my son, William Philipson, who has made the subjects of "Draught" and "The Suspension of Carriages" a special study for many years; and by my son, John Philipson, who has prepared many of the working drawings. The publishers also wish to express their indebtedness to the firm of Messrs. Hooper and Company, from whom the material for some of the illustrations of finished carriages was obtained. The Appendix contains "Remarks on the Weight of Carriages," by Mr. G. A. Thrupp, and some tables of Standard Sizes, and other important information, issued by the Institute of British Carriage Manufacturers, and printed by permission of the Council.

My friend Mr. John S. Foggett, one of the Coachmakers' Company's prize winners, has rendered important assistance in the preparation of the work. It has not been written solely to enable a student to pass a technological examination, but with the higher object of encouraging the cultivation of those other faculties which—if our work has to attain an ideal standard of excellence—are as necessary as the manual dexterity acquired in the workshop. The Company of Coachmakers and Coach Harness Makers, and the Institute of British Carriage Manufacturers have already done much for the encouragement of technological study, and this little text-book is a modest contribution to the same end.

J. P.

NEWCASTLE-UPON-TYNE.
October 18th, 1896.

CONTENTS.

CHAPTER I.

The principles of carriage construction. Designing The considerations which govern the shape and size of the body.--The number of persons to be carried. The dimensions of seats, leg room, head room.—Open carriages. Close carriages.—Carriages with folding heads.--Ease of ingress and egress Carriages for exportation. special requirements of different countries, head covers, ventilators, usual wheel tracks in different countries Special materials for various climates.—Standard sizes

IN designing a carriage the builder has in many things to trust to his own perceptions, quickened by the results of trials, some successful, others unsatisfactory. Like an engine, a carriage is built to perform certain work, but the coachmaker is at a disadvantage compared with the constructor of an engine. The engineer can calculate accurately his load, and can determine mathematically the dimensions and proportions of various parts; he attains his object as simply as possible, rejecting all curves and lines which do not give uniform strength or stiffness. The coachmaker is never certain what load his structure will be called upon to carry. He does not know the condition of the roads upon which it will run, at what speed it will be drawn, or the excessive strains which may be caused by collisions, horses shying, etc., and he must, therefore, provide strength, and if necessary err on the side of safety when making his calculations. In many things the coachmaker must abandon science and appeal to art. He cannot reject curves, because beauty of outline and

proportion is one of the principal attributes of a good carriage, and from the beginning he must calculate future effect, and draw a mental picture of the collective result of the whole.

Formerly, the majority of carriages were built to the order of their owners, who gave the maker precise instructions as to their requirements. With such data to guide him, the coachmaker produced very accurately constructed carriages, strong, comfortable, highly finished, and adapted to the place where they were to be used. To-day the average carriage user chooses a finished vehicle as it stands in the show-room; it may be the shape of the body, or the colour of the painting, or the style of the trimming, which pleases his eye and determines his selection. He is seldom, very seldom, a judge of quality.

If we compare the carriages of to-day with those of fifty years ago, the first thing that strikes us is the difference in size. We have continuously reduced the size and weight, and it follows that in reducing the dimensions and the substance of the materials of which our carriages are constructed, we have in some degree impaired their durability, and have sacrificed a certain amount of comfort; but we have gained compensating advantages. Our carriages being much lighter than those of our ancestors, are drawn along more quickly, and with less expenditure of horse power, while they do less injury to the roads and are more graceful in appearance, but we have to guard against the extra vibration caused by the higher speed.

In a chapter on "Bodies in General," written by Felton a hundred years ago, the author said: "There are few mechanical structures executed with a greater nicety than this." The body is the most essential part of a carriage, and is that to which all others are accessory. It is the part that demands the most skilled workmanship and taste to produce, and it is consequently the most costly. Con-

siderations of weight cause us to make it light; yet it must be rigid enough to bear the load it has to carry without the slightest change of form. There is no structure composed of a combination of wood and iron which has to bear so great a strain in proportion to its dimensions as a carriage body, and there is no branch of manufacture in which that combination has been brought to such a state of perfection as in coachmaking.

It has been well said that "the elegance of a carriage depends on the perfection of the outlines, and everything which tends to disturb those outlines should be avoided." Our principles of form have undergone little change during the last century. Fashion causes us at one time to make the outlines of our bodies a series of well adjusted curves; at another period the outlines are a series of angles; or, it may be that custom decrees a combination of curved and straight lines. In recent years we have witnessed a marked reversion to old-fashioned types. The curved lines, the round quarters and doorway of former days have been revived, each builder making slight variations to suit his individual taste.

The skill and taste of the carriage designer manifest themselves not only in the mere outline of his productions; they are evident in the manner in which he combines that outline with the side-sweep—*i.e.*, the curve from end to end—and with the turn-under, *i.e.*, the curve inward and downward from the elbow line.

Moderation in both side-sweep and turn-under give the most pleasing results, whether the round of the body be one regular curve, or whether there be one curve at the quarter and another at the door. With a sufficient degree of side-sweep we prevent any need for a sudden contraction in the width of the boot, and by rounding the body we gain, amongst other things, the necessary width of seat without increasing the length of our hind axle; but we must avoid

extremes, or we shall have to make the pillars unduly thick and heavy.

Figs. 1, 2, 3, and 4 are types of fashionable carriages of the present time. Nos. 1, 3, and 4 show the curved lines at present in vogue, and which were customary thirty or forty years ago. No. 2 is a combination of curved and straight lines. Not only are the outlines of the first three graceful and pleasing to the eye, but such carriages are stronger than those of angular shape

The girder of the architect or the engineer is regular in form or section, and offers no obstacle to accurate calculation. The body edge-plate of the coachmaker is never regular, and presents great difficulty. The body-plate of a victoria, like fig. 1, is much stronger than the body-plate of an angular phaeton. Owing to the change of direction of the fibres of the iron, there is a source of weakness at the points A and B (fig. 5, page 11), but the danger is very much greater at the sudden angles C and D in the other edge-plate.

As an introduction, it is essential that we should enumerate the different parts of which open and close carriages are composed, and give the names by which those parts are commonly known in various parts of the United Kingdom.

Figs. 1 and 1*a*, 2 and 2*a*, have been made for this purpose. In 1 and 2 those parts only are numbered which are visible to the eye when the carriage is finished.

Figs. 1*a* and 2*a* are skeleton bodies, in which the reader may discern the framework of the structure, and identify each part by its number and name.

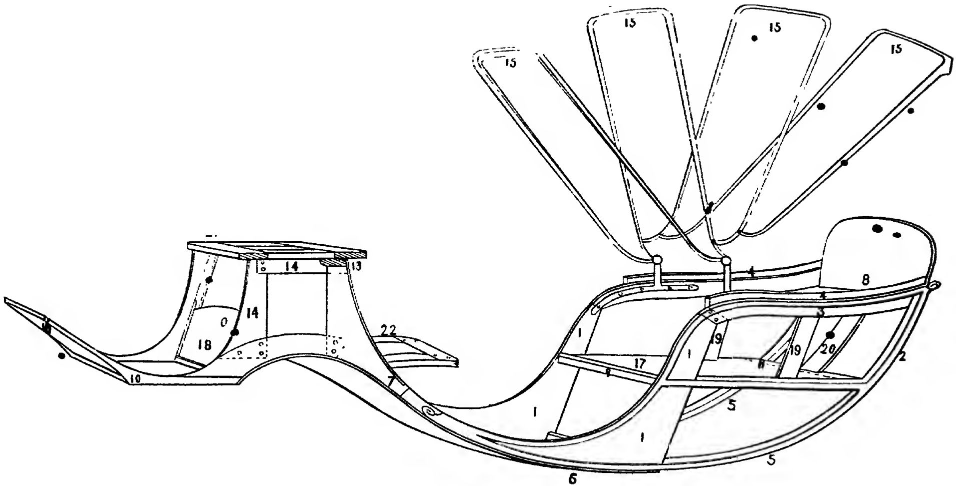


FIG. 17.—VICTORIA BODY.

Fig. 1a.—Victoria Body.

1. Front Pillar, or Sham door pillar or Anglet.
2. Hind corner pillar
3. Elbow.
4. False elbow
5. Bottom-side
6. Rocker bottom-side.
7. Boot-neck pillar
8. Back rail
9. Seat rail
10. Bracket
11. Back bar
13. Boot bar.
14. Boot framing-pieces.
15. Head sticks, slat or hoop-stick.
16. Footboard
17. Seatboard.
18. Heelboard
19. Quarter battens.
20. Back ,,
21. Framed boot seat
22. Framed shut up seat

Fig. 2. Brougham.

2. Roof
3. Moulding
4. Door top rail
5. Fence rail
6. Door panel.
8. Step shank.
10. Top quarter panel.
11. Elbow.
12. Lower quarter panel.
13. Moulding
15. Lamps.
16. Boot side.
17. Arch panel.
19. Bracket
20. Bracket heel
21. Footboard
22. Dasher
23. Heelboard
24. Seat-fall.
25. Long box.
26. Driving cushion
27. Seat valance.
28. Boot seat rail.
29. Pump handle
30. Hind spring-bar or bed.

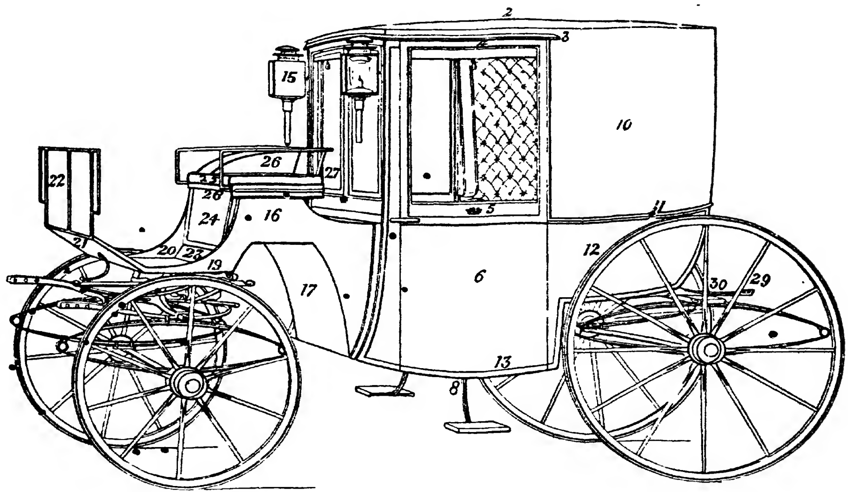


FIG. 2.—SINGLE BROUGHAM, ON ELLIPTIC SPRINGS.

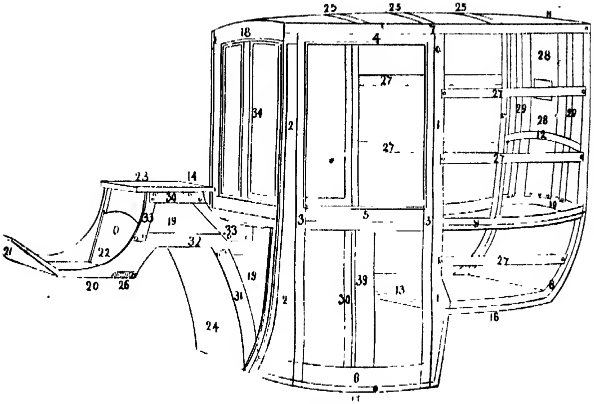


FIG. 2a.—BROUGHAM.

FIG. 2a.—BROUGHAM.

1. Standing or hinge pillar.
2. Front or lock pillar.
3. Door pillars.
4. ,, top rail.
5. ,, fence rail.
6. ,, bottom rail.
7. Cant rail.
8. Corner pillar.
9. Elbow rail.
10. Back rail.
11. Back top rail.
12. Back cross rail.
13. Seat rail.
14. Boot cross rail.
16. Seat bottom-side.
17. Rocker.
18. Front rail.
19. Boot side.
20. Bracket.
21. Boot footboard.
22. Heelboard.
23. Seatboard.
24. Arch panel.
25. Roof sticks.
26. Boot bar.
27. Quarter battens.
28. Back-light board.
29. Back battens.
30. Door battens.
31. Boot contracting piece.
32. Boot neck.
33. Boot side framing.
34. Upright front rail.

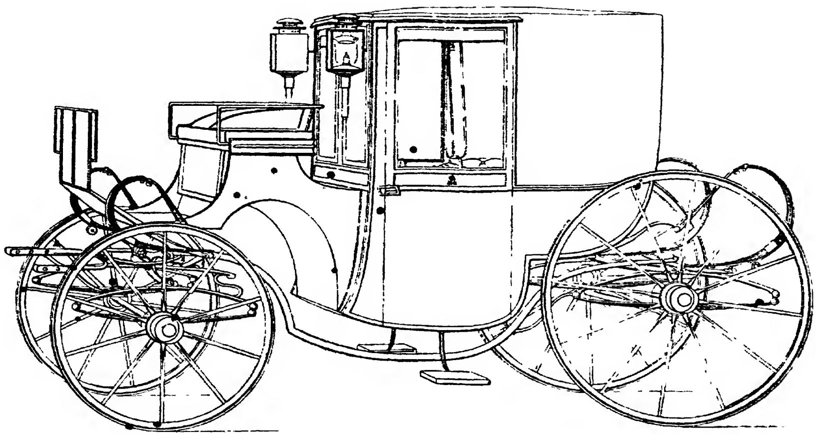


FIG. 3. —SINGLE BROUGHAM, HUNG ON C AND UNDER-SPRINGS WITH PERCH.

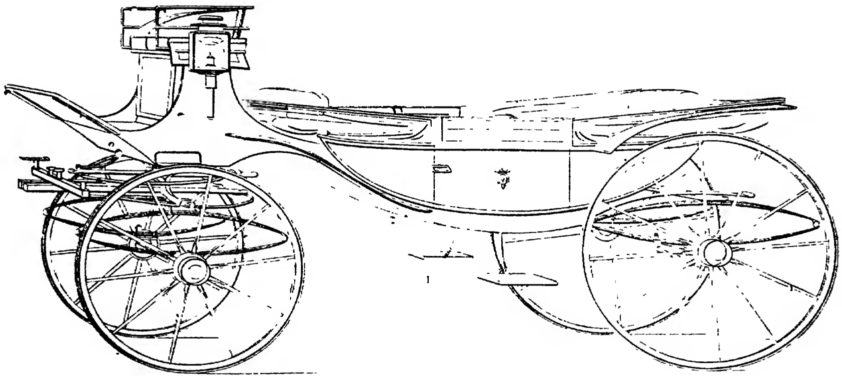
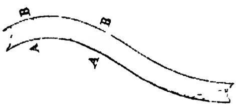


FIG. 4. LANDAU, ON ELLIPTIC SPRINGS.

There are many important considerations which govern the construction of a carriage, in regard to both its shape and its dimensions, and the draughtsman must always keep these considerations to the front as he proceeds with his work. Such of them as apply to the under-carriage will be more appropriately dealt with under the heading of Suspension. They include such questions as determining the sizes and position of the wheels; the stability of the carriage, so that it may lock or turn without danger of rolling over, or of the wheels touching the arch panel; determining the length of the axles, the distance between the collars and flaps, the dimensions of the springs, etc.



For the present we will confine ourselves more particularly to those considerations which influence us in giving certain dimensions to the body.

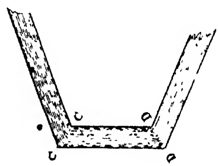


FIG. 5.

The size and weight of a carriage depend chiefly upon the horse-power to be used, and here let it be remarked, that a turnout always looks better when it appears over-horsed rather than under-horsed. The two primarily important measurements are the length from back to front and the width between the pillars. Next in importance come the questions of leg room, *i.e.*, the distance from the seat to the floor, and, the height from the seat to the roof.

Leg room is of course dependent not only upon the shape of the carriage but upon the length of the carriage, the distance between the seats and their width or depth. For instance, the angular form of landau gives more

depth than the canoe shape. Just as we increase length and breadth we increase weight, for our parts must be stronger and our under carriage longer.

The accompanying table of proportional measurements[1] has been prepared by Mr. C. W. Terry, of the London Correspondence Class, and is a compilation of considerable value as a reliable guide to the dimensions of carefully-designed carriage-bodies of modern construction.

It would appear needless to point out that it is impossible to lay down a table of arbitrary measurements such as these. There are many good builders who would object to some of the measurements given as being too large, and as resulting in heavy work. Customs differ not only in various parts of the kingdom, but in different factories in the same locality. A single-horse landau on elliptic springs by one London builder may measure 5 ft. 4 in. on the elbow line, 3 ft. 4 in. on the seat, and weigh 11 cwt; while another one-horse landau by a different maker may measure 5 ft. 8 in. from back to front, and 3 ft. 6 in. on the seat, and weigh only a few pounds more than the former, because the builder of the latter saves weight in his axles, wheels, and underworks.

Although a table of definite sizes cannot be given, it is worthy of notice that in such things as "head room"—*i.e.*, the distance from the seat to the inside of roof—and the depth of seats, there has been very little variation for many years. One hundred years ago chariots used to measure from 3 ft. 6 in. to 3 ft. 10 in. from seat to roof, while to-day an average brougham measures 3 ft. 5 in. or 3 ft. 6 in., and an ordinary landau 3 ft. 7 in. under the hoopstick at the side. These measurements are little enough, and have

[1] The idea of tables of this kind is due to Mr. G. N. Hooper who, in 1867, prepared some for the guidance of those who supplied his firm with wheels, axles, springs, etc. Mr. Hooper's tables have never been made public.

many times been objected to as causing a person to stoop very much when entering or leaving the carriage, especially when a high hat or bonnet is worn, but there are many good reasons why the height is not increased.

It will be seen by the table of dimensions that the width of carriages on the seat rail, or, in other words, the length of the seat, varies from 3 ft. 2 in. to 3 ft. 9 in. Wherever possible, the seat should be 18 in. from the hind bar to the front edge of the seat, and never less than 16 in. In such carriages as landaus we may very advantageously make the seat ¾ in. or 1 in. higher in front than at the back, as this throws the sitter into an easy posture, prevents him sliding forward, and takes strain off the ankles when sitting for a long time.

If we allow 12 in. from the seat board to the floor, and if we provide a cushion 3 in. thick, we secure a depth of 15 in. for leg room in a vertical line; but leg room should be measured forward diagonally, and 24 in. allowed if possible. The designer must also take into consideration the question of easy and comfortable ingress and egress.

The body of a single brougham may be said to be divided into two nearly equal parts, the quarter and the door. If the length of the body on the elbow line be 3 ft. 6 in., the quarter may be 21 in., and the door 21 in.

In a double brougham we have three divisions: the hind quarter, the door, and the front quarter. The divisions may measure, respectively, 22 in., 22 in., and 12 in., *i.e.*, for a carriage with a contracted front quarter, and front seat that is only intended for occasional use. In a landau 5 ft. 4 in. from back to front the dimensions may be: hind quarter, 21 in.; door, 23 in.; and front quarter, 20 in.

When dealing with the height and length of the boot, the draughtsman must aim at having it as high and as far forward as the length and shape of the body will admit, but it must never appear to be anything but a part of one

harmonious whole. In the case of a landau, it should be long enough for the folding head to clear the driving seat in falling, and it should be high enough to give the driver the requisite power over the horses in driving, and to allow the fore-carriage to turn round without the body having to be raised by means of deep blocks.

The proper inclination of the footboard is a point too often neglected. Opinions differ on this subject, but it should always be remembered that too great or too small an angle throws unnecessary strain upon the limbs of the driver, and causes much discomfort, and frequently numbness. The driver needs an average length of 24 to 28 in. from his cushion to the footboard, measured forward diagonally. It may be that the distance from the seat to the footboard is 22 to 24 in., which, with the combined height of the driving-box and cushion, gives the required distance; some coachmen prefer an inch or two more than this, particularly with pulling horses. In carriages like the sociable and the victoria, with folding heads, it is desirable to allow two or more inches additional head room, and this is the more necessary in a vehicle like the mail phaeton, which is often driven by its owner, who may be tall, and who will probably wear a silk hat and sit on a high driving cushion.

To effectively and safely dispose of the glass frames is sometimes a very difficult matter, particularly in landaulettes and landaus with front or quarter lights. In landaulettes with glasses which drop into the front end it is often impossible to obtain a sufficient depth to conceal the glass entirely, and there is always a risk of breakage when the frames are exposed. Door panels must be deep enough for the door glasses and blinds, or it becomes necessary to increase the depth of the fence rail. The glass frames should fit tightly at the rail and at the door top, to prevent rattle; and provision must be made in the bottom of the

door, by means of rubber or other material, to deaden shock and prevent breakage when the frames drop into the door.

The "driving" footboard without a dasher is now widely used on landaus and sociables, but the position of the dasher and the dress preservers, or wings, on those carriages which have them, call for some little care on the part of the draughtsman.

A high dasher has an objectionable appearance, but it must be high enough to keep the reins clear of the horse's tail. The wings, or dress preservers, must be of such a length and breadth as to prevent mud being cast up against the body by the wheels, but they should not be so long, either in front or behind, as to be unsightly, and they should, wherever possible, conform to the shape of the carriage, and not create a broken outline. They must, moreover, be bored on so that, when the carriage is fully loaded, they do not catch the wheels, or conceal the crest or other heraldry.

In designing and building carriages for foreign markets the coachmaker has to deal with a number of difficult problems, which do not trouble him when making carriages for the United Kingdom. It is necessary that he should know something of the country for which he is building, whether the climate is hot or cold, wet or dry. Carriages for cold climates require to be somewhat roomier than those for temperate regions, on account of the rugs and wraps which are used. If the climate be hot, his timbers will have to be specially selected and thoroughly seasoned and dried by artificial heat, otherwise his work will be a failure, and will bring him discredit. For hot climates there must be efficient ventilation, either by means of louvres in the panels of closed carriages, or by the leather hoods of open vehicles being made to roll up at the back or sides.

The Institute of British Carriage Manufacturers some

years ago collected a mass of valuable information relating to the requirements of carriage users, in various parts of the world, and with the permission of the Council a summary is given in the appendix to this book, in order that it may be available, not only to the builder engaged in supplying foreign markets, but to the student who, at some future time, may be called upon to produce working drawings of a carriage for some foreign country. He will then want to know whether the roads are hilly or flat, rough or well kept, hard or soft, and what is the average wheel track, which in some countries is as much as 60 in., while in others it is not more than 4 ft.

Native customs will have to be borne in mind, so that the painting, lining, and other embellishments may accord with the taste of the people for whom the carriage is intended. A knowledge of the standard dimensions of axles, axle bushes, shafts, etc., recommended by the Council of the Institute of British Carriage Manufacturers, will prove to be of considerable value to the carriage draughtsman, for whose benefit some tables issued by the Institute are given in Chapter VII. and the appendix.

CHAPTER II.

THE DRAUGHT AND SUSPENSION OF CARRIAGES.

DRAUGHT, or the forces acting on the carriages.—The angle of draught.—Rolling friction.—Axle friction.—Coupling.—Two-wheelers *versus* four-wheelers.—Position of the load.—Point of draught.—Speed.—Springs.—Tyres.—Track.—Traces.—Shafts.—SUSPENSION.—Ease of Motion.—Ingress.—Egress.—Turning.—Stability.—C-spring carriages.—Carriages with perch but without C springs.—Carriages without perch, and mostly on elliptic springs.—Two-wheeled carriages.—SPRINGS.—Proportion.—Position.—Inclination fixing.—AXLES.—Setting axles.—Testing carriages.—BRAKES.—Varieties.—Position of blocks.—Power of levers.—Methods of applying the power.—Brake blocks.—Brakes for two-wheeled carriages.

BRIEFLY defined, the draught of a carriage is the force or power that is required to draw it. If the carriage is drawn by a horse, the draught is the total of the pull of the two traces.

We will commence our consideration of this important subject with the most primitive form of vehicle, viz., the sledge. The forces acting on it are the *Power*, *Weight*, and *Resistance*, the same forces that act on the most elaborate carriage, and not having the wheels to consider in this case, we are better able to observe the general principles that affect the draught of carriages.

Suppose the diagram (fig. 6) represents a sledge on the point of being drawn along the level road, X Y, in the direction of Y by the *power* P. We know that the *weight* of a sledge is a distributed force (on the two runners), but by

well-known rules in mechanics we can treat it as one force by supposing the weight to be collected at a certain point, called the *centre of gravity* of the sledge. Let that point be G. Then, if G W is a vertical line, it will represent the *weight*, W, acting downwards. While at rest, no other force is acting on the sledge except the *resistance*, R, and this is equal and opposite to W, and will be represented in magnitude and direction by W G. The sledge, however, is not at rest, but acted on

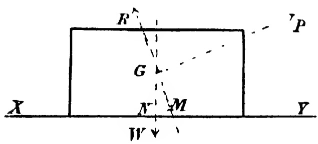


FIG. 6.

by the *power* P, and is on the point of sliding. The direction of R is not therefore W G, but G R, which is inclined to the perpendicular to the road at the *limiting angle of resistance*, θ, between the surfaces in contact, viz., the sledge and road. By the *triangle of forces* we know that if P, W, and R balance one another they can be represented in magnitude by the sides of a triangle whose sides are parallel to the three forces. If from N any point in G W we draw N M parallel to G P, then N M G will be such a triangle, therefore P will be represented by N M, W by G N, and R by M G. As we know W, the weight of the sledge, we can at once obtain a scale from G N that will enable us to measure N M the power, or M G the resistance. We can thus find out exactly the magnitude of the forces acting, in any particular sledge or carriage.

We next suppose the sledge being drawn up the incline X Y (fig. 7). We still have the same three forces, P, W, and R, but W resolves itself into two forces—one W^1 acting as a perpendicular pressure, G N, on the road, and the other W^2 as a sliding force, down the incline N W, parallel to the road. The value of W^2 varies with the incline, and

is found by multiplying the weight of the vehicle by the *sine of the inclination* approximately the percentage of the incline. Thus, if the sledge weighed 4 cwt. or 448 lb., and the inclination was 5 % (or 1 in 20), then $W^2 = 448 \times \cdot 05$ lb. $= 22 \cdot 4$ lb. This force of 22·4 lb. would be required in addition to the ordinary power P, so that the draught up an incline is $P + W^2$. On descending the incline W^2 acts down the incline, so that the draught is $P - W^2$. If the inclination is considerable, W^2 is very large compared with P, and in comparison might swallow it up. This should be borne in mind in considering high *versus* low wheels on an incline, as when the incline is considerable, any difference in draught from the height of the wheels is a mere nothing compared with the whole draught of the sledge or carriage.

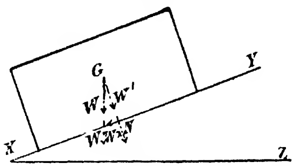


FIG. 7.

In the case where the sledge is on the point of sliding down the incline (fig. 8), we have the two forces, P and W^2 equal, viz., N R equal to W N, and consequently the angle N G R must equal angle W G N. The angle N G R we know is θ, the limiting angle of resistance between the sledge and road, so that W G N must also equal θ, and this is also the inclination of the road to the horizontal, viz., Y X Z, as G W is at right angles to X Z.

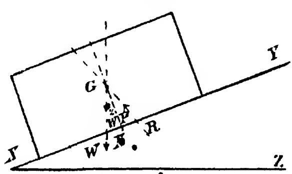


FIG. 8.

These results give a ready method for finding for ourselves θ, the *limiting angle of resistance* for any sledge or carriage on any kind of road. All that is necessary is to try the sledge or carriage on an incline of varying gradient, and when that part has been found that it will just slide down, then the angle that the road makes with the horizon is θ. It may be well to mention here, that for the same materials and the same conditions θ is constant. It is independent of the weight. Whether the sledge is loaded or empty, it will always begin to slide at the same part of the incline, that is, if all circumstances of physical conditions of the road are the same.

Angle of Draught.—The angle of draught should be at right angles to the line of resistance, that is, at the same inclination to the road as the line of resistance is to the perpendicular, viz., θ. the limiting angle of resistance. We thus have three angles all equal to θ:—(1) Y X Z, the angle that the sledge or carriage will just run down; (2) R G H, the angle that the force of resistance makes with the perpendicular to the road; and (3) P G I, the angle of inclination of the trace.

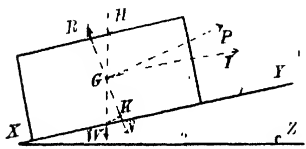


FIG. 9.

The exact amount saved by this inclination of trace is found by comparing W K and W N, for from W draw W K parallel to G P, then the side W K of the triangle G W K represents R, the power with a trace inclined at angle θ, and the side W N of the triangle G W N, P the power with a trace parallel to the road.

Point of Draught.—In our previous propositions we have taken for granted that the point of attachment of trace was the centre of gravity, G (fig. 10). Let us take a point in

front, viz. G^1, and let P be the point of attachment of traces to the horse's shoulder, then P G^1 is the line of trace. It is clear that instead of the sledge sliding, it will be tilted up in front. Again, supposing we take a point at the back, G^2, P G^2 will be the line of trace, and this time the sledge will tilt up from the back. It therefore follows that the centre of gravity (the intermediate point) must be the best possible point of draught.

We have reasoned on the understanding that horses of any height may be selected or procured. In practice coach-builders have to make the sledge or carriage to suit the

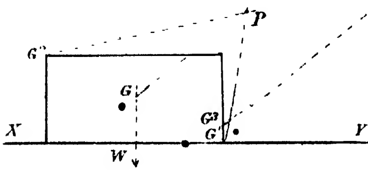


FIG. 10.

horse. We must therefore draw from P^1 the given height of horse's shoulder and distance in front of sledge to allow room for the horse's hind-legs to clear, a line at the correct angle θ, and make the attachment at G^3, where this line strikes the sledge. We have thus obtained the nearest correct point of draught and inclination of trace for the carriage, but looking at this point again, it may not be the best angle for the horse. We are told that his powers are used with least exertion when the trace is at right angles to the shoulder blade. This is generally an angle greater than the one already laid down as best for the carriage, but as this greater angle gives greater power to the horse, and helps the carriage over high obstacles,

such as a kerbstone or out of a ditch, it is safer to make the angle of trace, to suit the horse rather than the carriage.

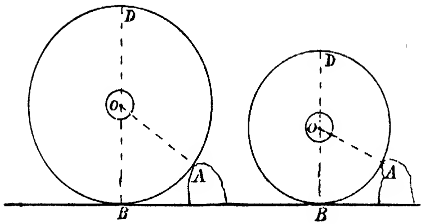


FIG. 11.

Rolling friction, or resistance at the tyre of the wheel.—The question of rolling friction is an interesting one, and several investigators have devoted a great deal of

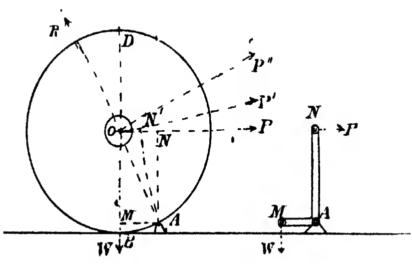


FIG. 12.

attention to it, notably General Morin and Mons. Columb. We need not go further here than state the result of their experiments, given in the following equation:

$$P = \frac{W \times \text{arc } A\,B}{R} = \frac{W\,a}{R},$$

Where P = force required parallel to the road to just move the wheel,

a = constant depending on the road,

R = radius of wheel,

W = weight of carriage and wheels.

Fig. 11 represents two wheels of different heights against obstacles of equal height = by the rule we know that the *arc BA* in both wheels is of the same length.

Another way of looking at the action of a wheel, which is perhaps easier to follow, is to consider it a kind of bell-crank or *toggle joint*, continually lifting the weight of the carriage over an obstacle (see fig 12). We then have the equation:

$$P \times A\,N = W \times A\,M,$$

$$\therefore P = W \frac{A\,M}{A\,N},$$

and as the obstacle is small we can substitute R for A N, we therefore come to the same result, that the draught of a carriage varies directly with the weight, and inversely with the radius, of the wheel.

In the diagram (fig. 12) we have supposed P parallel to the road if it is inclined, as in O P[1], then the long arm of the toggle joint A N[1] is lengthened, and we see once again the advantage of an inclined trace.

[1] This can be worked out further, for $\frac{A\,M}{A\,N} = \frac{A\,M}{M\,O} = \tan.\ M\,O\,A$, and as M O A is a small angle, its tangent = its circular measure;

$$\therefore \tan.\ M\,O\,A = \frac{\text{arc } B\,A}{R};$$

$$\therefore P = W \frac{\text{arc } B\,A}{R} = \frac{W\,a}{R},$$

as we know that the arc B A is constant.

Axle friction.—Axle friction is small compared with the other resistances acting on a carriage, and it is further reduced by the leverage of the spokes of the wheel, yet it cannot be overlooked, as the application of ball bearings (to axles) alone testifies. Fig. 13 shows the forces acting when the wheel is in the state bordering on motion.

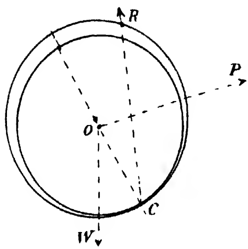


FIG. 13.

At rest the axle bears on the bottom of the axle-box and the line of resistance acts vertically upwards; as soon as P begins to act, the axle slides up the front of the axle-box and the line of resistance to the weight and power is in the direction C R, and when the wheel is on the point of turning on the obstacle, the angle W O C will equal θ, the limiting angle of resistance of the metals in contact.

The following equation gives roughly the amount of friction at the axle, and its effect on the draught of the carriage:

$$\left\{\begin{matrix}\text{Friction}\\ \text{at axle}\end{matrix}\right\} = \frac{\left\{\begin{pmatrix}\text{Weight of}\\ \text{Carriage}\end{pmatrix} - \begin{pmatrix}\text{Weight of}\\ \text{Wheels}\end{pmatrix}\right\} \times \begin{pmatrix}\text{Co-efficient}\\ \text{of friction}\end{pmatrix} \times \begin{pmatrix}\text{radius of}\\ \text{axle}\end{pmatrix}}{\text{radius of wheel}}$$

Coupling.—The question in draught, about which there is more discussion than any other, is the effect of long or short coupling of the two pairs of wheels on the draught of carriages. When pulling and pushing vehicles about in the manufactory, we realize how much easier a short and compact carriage is to handle and control, than one that is commonly called long-coupled. Yet, if the conditions are the same, the draught cannot vary. For

from the rules already given, we know that the draught is made up of two resistances, (1) of the wheels and the road, and (2) the wheels and axle-arms, and if the weights and other conditions are the same, the draught must be the same, whether on the level or incline. For the conditions to be the same it is not sufficient that we have the same height of wheels, axles, etc., also the same total load, but the load must be similarly divided; that is to say, the front and hind wheels must each carry the same proportion, also the stiffness or vibration should be the same: in most long-coupled carriages there is a certain elasticity or *give* in the body, as well as in the underworks, by which the wheels are attached, and this naturally disturbs the draught and wastes power.

While in favour of short-coupled carriages, we must not sacrifice everything for this. An omnibus is of lighter draught than a landau, owing to its better design, *i.e.*, carrying its load in a more scientific manner; in the former the small front wheels carry the load of two or three persons on the front seat, and the higher hind wheels, the load of eight or ten persons inside. In the latter, in most cases, the front wheels carry both the load of the two persons on the driving seat and the two on the front inside seat, while the hind wheels carry only the load of the two on the hind inside seat, or one-half of the load on the small front wheels. From this it is clear that a landau, owing to its construction, is always of heavy draught, yet, to please their customers, some coachbuilders will bolt the front carriage still further back, thus adding weight to the already over-loaded front wheels. We must certainly have the hind wheels as far forward as the opening of the door will allow, but on no account do we recommend bringing the front wheels unduly back.

Two-wheelers versus four-wheelers.—Many different views are also held with respect to the draught of two and four-

wheeled carriages; but if we bear in mind the rules which govern draught, it seems clear that if the wheels and other conditions, such as axles, load, and total weight are the same, there can be no difference in draught. As a rule, a two-wheeler has higher wheels, and again, there is something in a nicely-balanced dog-cart that makes it pleasant to drive. For ladies a four-wheeler is best, as there is less fear of personal injury, if the horse should stumble and break a shaft. In the days before railways, commercial men, who travelled great distances by road, all had four-wheelers; they found, that taking the hills and dales into consideration, their horses came back fresher after a three or four months' journey than when in a two-wheeler, which is always a heavy strain on a horse when going down hill. A two-wheeler does just the reverse of what we should aim at, for we know that a horse is very apt to stumble in going down hill, even with his own weight without any addition, and that in going up hill he can obtain a much better foothold if there is weight on his back. A low-hung cranked axle cart has the action we desire, but the majority of people prefer to run the risk, and adhere to the ordinary cart with straight axle.

Position of the load. We have referred to balancing the load in a two-wheeled cart, and it is not necessary to add more remarks here, as all riders know the necessity of a balance, both for their own ease and that of the horse. In a four-wheeler the same care should be used. We can easily imagine that a four-wheeler, with nearly all the load on the hind wheels, when being drawn by the horse would not run steadily; but the front wheels would be jumping up off the road every now and then, and this would require extra work from the horse, and would not add to the comfort of the riders. The same action would follow if all the load were carried on the front wheels. For a perfect-running carriage the load should be so distributed that the hind

wheels have as much greater share as they are higher than the front wheels, *i.e.*, the respective loads should vary directly as the heights of the front and hind wheels.

Point of Draught.—At the beginning of this chapter we found that the best angle of draught for a sledge was that incline down which the sledge would just slide if left to itself. This holds good equally for a wheeled carriage, though the angle is much less, and, as before named, we should regulate the angle of trace to suit the horse, viz., at right angles to the shoulder-blade. The other question as to the point of draught is rather different in a carriage than in a sledge. Taking a two-wheeler first, we find that the *centre of the axle* is the correct point of draught; for if the trace is attached above this point it disturbs the balance, and weight is thrown on the horse's back, and if the point of draught is below the centre of the axle, then the weight is thrown on the belly-band of the harness. In a four-wheeler it is a point in the line joining the two axles, so that the distances of it from the centres of axles are in the inverse ratio of the forces required to pull them. If any other point is tried it will be found that the balance of weight on the front and hind wheels is disturbed.

Speed.—The forces acting on a carriage in motion are very varied, but suffice it to say that the draught of a carriage is considerably increased with the speed. The rule is that the increment of draught is in proportion to the increment of speed. Thus, if it take 10 lb. to pull a carriage at the rate of four miles per hour, and 11 lb. at five miles per hour, then it will take 12 lb. to pull it at six miles per hour.

Springs.—When a carriage is moved quickly along, springs reduce draught. Suppose a carriage meets an obstacle 1 in. high. If it has no springs the body is lifted up 1 in., but if the carriage is fitted with springs they will be compressed with the shock of the wheel striking the obstacle, so that the

body will only be raised a part of the 1 in., though the wheel, as before, will have gone over the obstacle. It may be worked out in foot-pounds; say the carriage weighs 10 cwt., or 1,120 lb., and this being raised 1 in., the work done is

$$\frac{1{,}120 \times 1}{12} = 93\tfrac{1}{3} \text{ foot-pounds (if no springs).}$$

In the second case, if we suppose the body only lifted $\frac{3}{4}$ in., then the work done is

$$\frac{1{,}120 \times \frac{3}{4}}{12} \quad 70 \text{ foot-pounds (if with springs),}$$

thus showing a saving by having springs of $23\frac{1}{3}$ foot-pounds.

Pneumatic and solid rubber tyres reduce draught, in the same way, as the obstacle becomes imbedded in the tyre, and the carriage is not lifted the full height of the obstacle, but only a fraction of it. This advantage chiefly refers to the former, as the latter is not indented by the obstacles to the same extent, and there is also the grip of the road, which is much more than with iron tyres, and this sometimes increases the total draught rather than decreases it.

Shape and width of tyres.—There seems very little difference in draught, if any, between flat and half-round tyres if the roads are good. If the roads are soft, then good wide tyres are a necessity, but for ordinary roads an $1\frac{1}{2}$ in. to 2 in. tyre is quite wide enough, and the section with the rounded projecting edge is preferred, as it preserves the paint and wood from wear. The half-round tyre on a muddy day is cleaner in not lifting the mud, but it is very awkward when crossing or leaving tramways, as it runs in the grooves and strains the wheels and axles.

Track.—Within reasonable limits the width of track does not affect the draught, though the hang of the axle and foregather of the axle arms add slightly to it. The

front and hind wheels should track, so that they run in the same rut; this is especially important in snowy weather and on bad roads.

Springs in traces do not reduce the draught of the carriage, but ease the horse considerably, especially with heavy loads, by reducing the strains on the shoulders at starting. Another advantage to the horse of the same nature is the adoption of pulling bars, or swingle trees, they allow the natural action of the horse's shoulder, and adjust the bearing of the collar to it.

The proper running of carriages varies according to the way the horses are attached; the pole between the two horses is the steadiest, and therefore the best for draught. The steady easy running of a carriage depends a good deal on the horse or horses, also on the position of the perch bolt; in most open futchell carriages with hinged shafts there is a constant sway every time the horse takes a step, and this all means loss of power, although the action of horses varies considerably. The shafts in a two-wheeler have not this disadvantage, as they are fixed; but sometimes they are made too wide for the animal, and consequently move from side to side, and so inconvenience the horse and the passengers, as well as increase the draught.

We will now briefly summarize the different resistances that make up draught, and the objects to be kept in view, when designing and building any carriage.

(1.) *Resistance offered to the rolling of the tyres on the road.*—The wheels should be as high as possible for the height of horse.

(2.) *Friction of the metal box round the axle.*—The axles should be as small as possible, though on no account to sacrifice safety, as the saving in friction between a $1\frac{1}{4}$ in. and $1\frac{3}{8}$ in. axle is infinitesimal. The axle-box should be of good length, in order that there may be a steady

bearing surface; the length of the box[1] does not affect the friction.

(3.) *Force of Gravity.*—As the draught of a carriage varies directly with the weight, *i.e.*, a carriage weighing 8 cwt. being twice as heavy to draw as one 4 cwt., the vehicle should be as light as may be consistent with its work, especially in hilly districts, as many carriages within the power of one horse in a flat country require a pair where there are hills.

(4.) *Speed at which the carriage is drawn.*—As the draught increases with the speed, so do the strains; more than ordinary care must therefore be taken in carriages intended for quick running; they should be as light and strong as possible.

(5.) *Angle of Trace.*—The angle of trace, (1) for the horse should be at right angles to the shoulder-blade; and (2) for the carriage, at right angles to the line of resistance, viz., at the angle θ to the road, where θ is the limiting angle of resistance between the carriage and the road.

(6.) *Point of draught.*—The point of draught, (1) in a sledge, should be low down in front; (2) in a two-wheeler, the centre of the axle; and in a (3) four-wheeler, a point on the line joining the front and hind axles.

(7.) *Position of the Body on the Wheels.*—The body in a (1) two-wheeler, should almost exactly balance on the axle, only, say, 7 lb. being on the horse's back, and in a (2) four-wheeler, the hind wheels should carry as much greater proportion of the load as they are higher than the front wheels.

Having seen what points are to be observed in order to make the horse's work as light as possible, we will turn our attention to some other characteristics of a perfect

[1] The sizes recommended by the Institute of British Carriage Manufacturers are given in a table at the end.

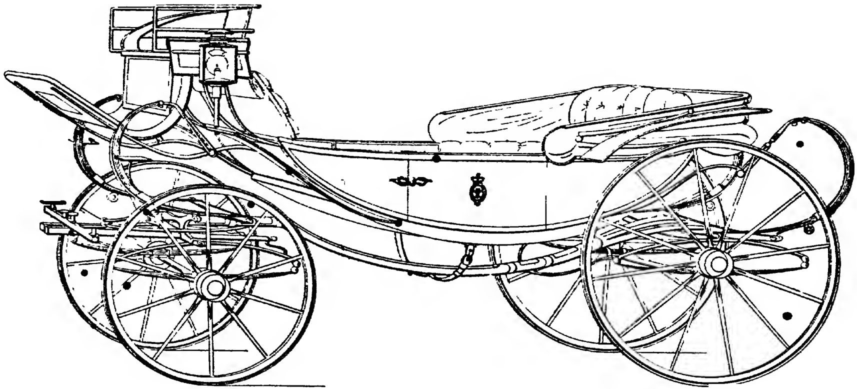


FIG. 14.—C AND UNDER-SPRING BAROUCHE. EXAMPLE OF CLASS I.

carriage. We have referred to them in the previous chapter, and they cannot be ignored without the builder's reputation being at stake.

(1.) Ease of motion.
(2.) Ease of ingress and egress.
(3.) Ease and safety in turning.
(4.) Stability.
(5.) Durability.

(1.) *Ease of motion.*—This is of much importance, for, unless the carriage is an easy one, it will be condemned, however well it may be otherwise built.

(2.) *Ease of ingress and egress.*—Ladies at once condemn a carriage if the steps are not placed so that they are able to ascend with ease, and without catching their dresses, or scraping the mud off the wheels. In the United States they are not so particular, if one may judge from the small space between the wheels in an American buggy left for mounting or dismounting. Care should be taken that the wings of the carriage overhang the wheels sufficiently to prevent mud coming in, but they ought to be kept within the stock hoops to avoid injury when passing vehicles. In a brougham the wheels should have sufficient dish to throw the mud clear of the top quarter-panel and the door-handles. Wheels with solid rubber tyres, and especially those with pneumatic tyres, require more dish than with iron or steel tyres, as they have a greater tendency to lift the mud.

(3.) *Ease in turning.*—Not only ease, but safety and quickness in turning is a desideratum. The modern London 'bus for a short-lock carriage is as near perfection as possible. It is interesting to notice the skill with which their drivers dodge one another in the Strand when the street is crowded with vehicles of all kinds. In the

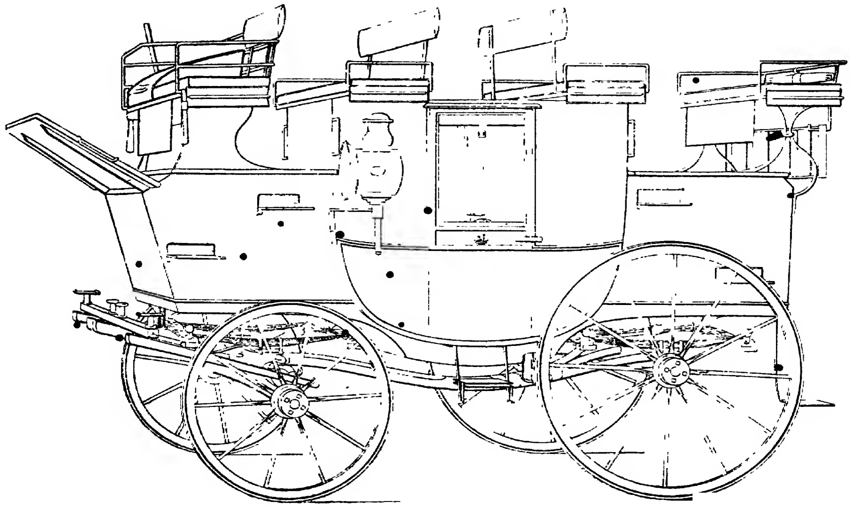


FIG. 15.—MAIL-COACH EXAMPLE OF CLASS II. (1)

country a full-lock is nearly always required; this occupies a lot of room, but in many carriages the "arch" or "wheel-house" adds to their light appearance. The distance back of the arch depends on the track and position of the perch-bolt, whether there is a straight or compassed bed. There are other methods of turning, such as hinged axles, hinged bodies, like that of the equirotal carriage invented by Mr. W. Bridges Adams, etc., but they are inconvenient in many ways, and need not be referred to here.

(4.) *Stability.* Of all carriages, the most unstable is the mail-coach, with its load of luggage and passengers on the roof, and often empty interior. It is not surprising that accidents sometimes occur to it; the wonder is that coaches are not more frequently overturned, and particularly those with light under-carriages usually built for amateur coachmen. In nearly all modern carriages, however, the load is kept low, and the importance of a low centre of gravity, and a good wheel base is appreciated.

(5.) *Durability.*- The life of a carriage depends on the way it is built and used. Too many carriages are injured and abused by running the wheels with slack tyres, no washers or oil on the axles, no paint to keep the springs from rusting, no paint or varnish to keep the wet from the wood-work. Still, we must almost expect this, and provide accordingly. We are far from having attained that perfection in carriage construction typified in Oliver Wendell Holmes' one-horse shay, which ran "one hundred years to a day" without repair, and then dissolved and disappeared: still, we should bear in mind his motto, and "make every part exactly as strong as the rest." Solid rubber tyres lessen vibration, and increase the life of a carriage. Pneumatic tyres do the same to a greater degree.

In their method of suspension, carriages can be classed under three main heads.

Class I. Four-wheeled carriages with bodies suspended

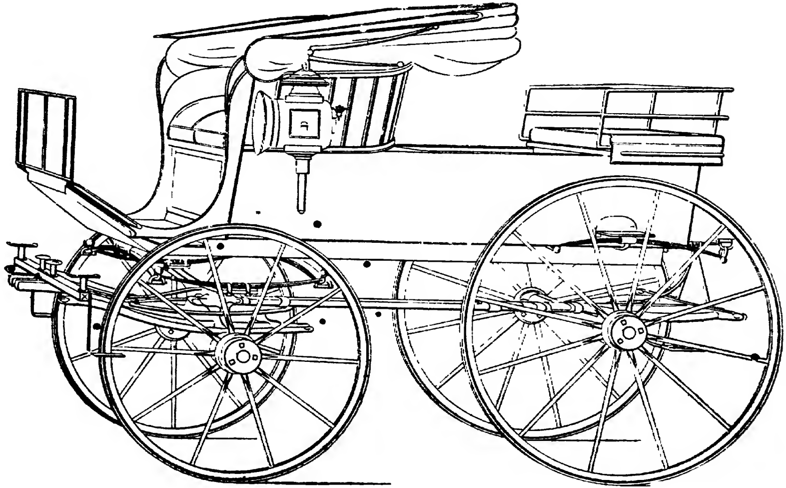


FIG. 16.—MAIL-PHAETON. EXAMPLE OF CLASS II. (1).

by leather braces from the springs (which is confined to those with perches) such as C-spring Barouches, Landaus, Broughams, Victorias, etc. (See figs 3 and 14.)

Class II. Four-wheeled carriages with bodies connected directly to the springs.

(1.) Those that have a perch, such as Mail-coaches, Mail-phaetons, American buggies, etc. (See figs. 15 and 16.)

(2.) Those that have no perch, such as the ordinary Landaus, Broughams, Victorias, Stanhope and other phaetons on elliptic springs. (See figs. 1, 2, 4 and 17.)

Class III. Two-wheeled cariages, such as Hansoms, Gigs, Dog-carts and Whitechapels (See figs 18 and 19.)

Class I. *C-spring Carriages.* This is practically the oldest method of suspending carriages on springs. It is also the most perfect that has ever been introduced. The wheels and underworks may go over the roughest roads, yet the passenger (in the body of the carriage) can ride without discomfort, as the leather braces change the short jerky motion caused by the wheel striking against obstacles and uneven places in the roadway into a pleasant swing. This swing affects the draught to a certain degree, but the great drawback to this method of suspension is the extra weight that it entails, and the extra cost. Compared with the number turned out in former years, few C-spring carriages are built now, even in London, and as they are gradually falling into disuse we need not devote further time to their consideration.

Class II. (1) *Carriages with a perch but not on C springs.*—This class has many of the advantages of the last, without the swinging action of the leather braces and its consequent increase in draught. The examples that we illustrate are the mail-coach and the mail-phaeton. It will be observed that the advantage of the "platform" or "Telegraph" system of springs (two side and two cross)

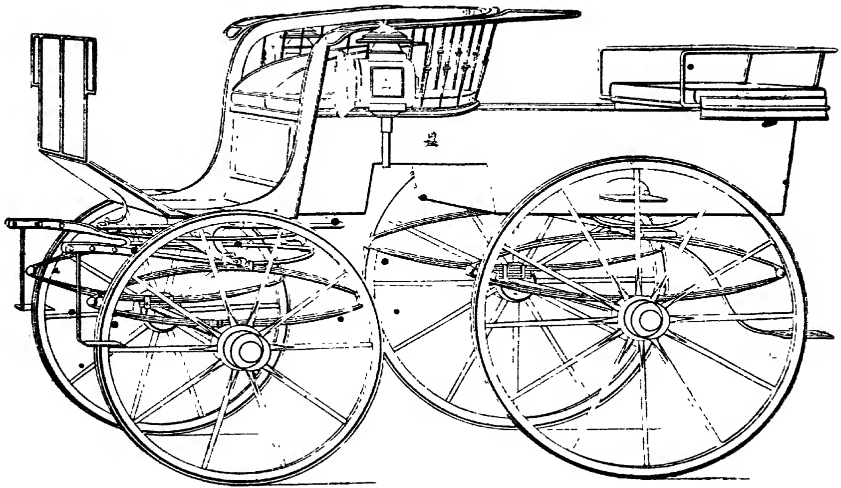


FIG. 17.—STANHOPE PHAETON. EXAMPLE OF CLASS II. (2).

used in both these carriages, is that it enables the body to be kept low. Any other system for suspending the mail-coach with a perch would make it so high that no one with any regard for their personal safety would ride in it. The other example, that of an American buggy, is not illustrated. A large proportion of such American carriages are built very light, and if we leave weight out of the question, we find that the only difference between the buggy and other elliptic spring carriages is that it has a perch. Perches are of different design, but both in Class I and here they act as the back-bone of a carriage, keep the whole vehicle fair and square, and allow the body to be made lighter. The perch also helps to reduce draught, as the pull of the trace is conveyed direct to the front and hind axles, and not through the body and springs to the axles, as in carriages without perches.

Class II. (2) *Carriages without perches, and mostly hung on elliptic springs.*—This is by far the largest class. It has its origin in the invention of Mr. Obadiah Elliot, who invented the elliptic spring and patented it May 11th, 1805, which enabled a carriage to be hung on springs without a perch. We have illustrated a landau, brougham, and victoria, and we now show a Stanhope phaeton (fig. 17) hung in the same way, but built for the owner to drive himself. The advantage of all the carriages in this class over the others is their lightness, and the possibility of obtaining a full lock. Instead of elliptic springs at the back, sometimes "Five" springs are used (viz., side, elbow, and cross).

Class III. *Two-wheeled carriages.*—The two-wheeler has for long been a favourite carriage in England, Scotland, and Ireland, but never has it been used to such an extent as at the present day. The Stanhope gig (fig. 18), has been in vogue for generations, and it is almost impossible to ride in a more comfortable carriage. It is hung on four

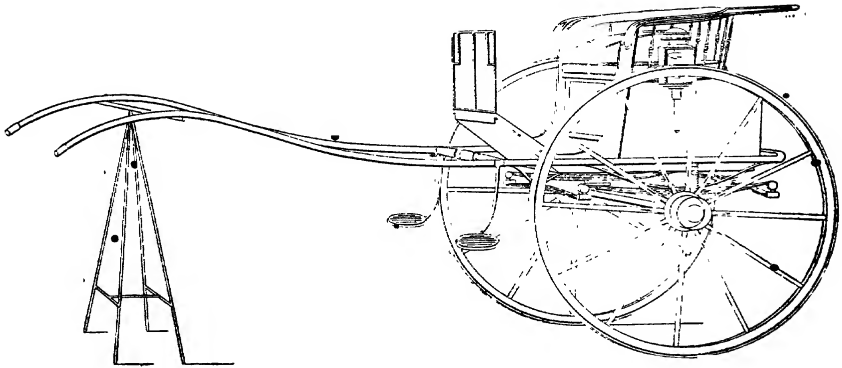


FIG. 18.—STANHOPE GIG. EXAMPLE OF CLASS III.

springs (two side and two cross), known as the "platform" or "Stanhope" system. If hung on three springs (two side and one cross) only, then the gig is known as the "Dennett." The other illustration (fig 19) shows a tandem-cart on two "side" or "Grasshopper" springs, this is a favourite method of hanging dog-carts. The drawing shows a pulling bar with chains from the axle as recommended, the horse pulling direct from the axle.

SPRINGS AND AXLES

(1.) *Proportion of Springs.*—The strength of a spring varies inversely as the length, directly as the number and breadth of the plates, and as the square of their thickness. Its flexibility increases at a much higher rate than its strength. A spring should be of good length, with fairly wide thin plates, but there are other things to be remembered. It would not do to have long springs to a carriage hung on very low wheels they would look out of proportion. The front springs having to withstand more strains (obstacles meeting the small front wheels first), are generally rather stronger than the back, otherwise they should be of the same strength, that is, they should be calculated so that they may deflect equally with the load, in order that the body may remain level when loaded as well as when empty. In designing any system of combination of springs equal care should be taken that the deflection of the springs is evenly distributed. Taking the case of the side spring A B (fig. 20), that deflection of the arm C A is equal to the deflection of the arm C B, and taking the case of the whole system (known as the Dennett), that the deflection of the arms in front of the axle, viz., A C and A′C′, is equal to the joint deflection of the half cross spring and half side spring behind the axle, viz., C B + B D and C′ B′ + B′ D.

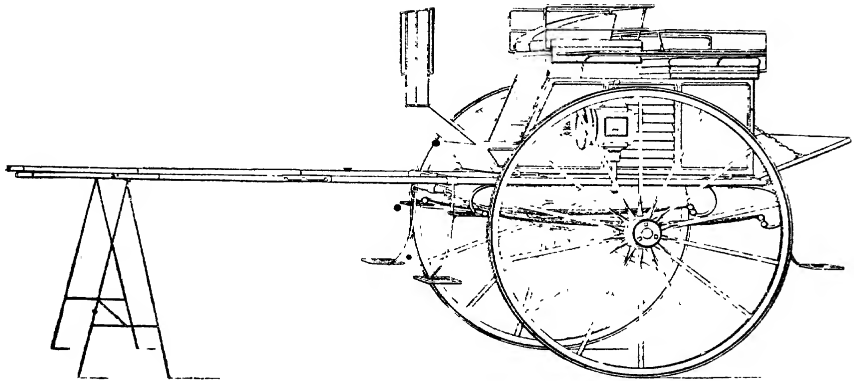


FIG. 19.—TANDEM CART. EXAMPLE OF CLASS III.

This is best obtained in the side spring A B by having the arms of equal length and equal strength, viz., A C C B, but in the Dennett system, if the arms of the side and cross springs are all equal, there is no balance, as the deflection of the arms C B and B D will be double the deflection of the arm A C (also the deflection of C B′ and D B′ double the deflection of A′ C′), and the body being kept level, the axle is first twisted up and then down. This action alters the hang of the axle, and, consequently, increases the draught. The only way to obtain a balance

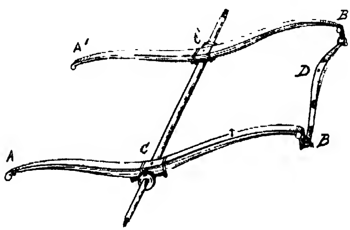


FIG. 20

in this or any other system of springs, is to balance the deflection in front and behind the axle, viz., lengthen A C or shorten C B till the deflection of A C is equal to the total deflections of C B and B D (also the deflection of A′ C′ equal to the total deflections of C′ B′ and B′ D).

(2.) *Position of Springs.*—Another point that has not to be neglected in suspending a carriage, is to ascertain that the springs are fixed in the position they are calculated for. If, for instance, the position of the hind bar or axle is not marked on the drawing, the carriage-maker may possibly fix the springs a little in front or behind their correct

position, in which case they have either too much or too small a share of the load, and the balance is destroyed.

(3.) *Inclination of the Springs.*—Again, in fixing the springs, the axle-block should be slightly thicker in front than at the back, this allows the front end of the spring to be a little up, and enables it to meet, at a better angle, the shocks caused by the wheels striking against obstacles; an ordinary elliptic spring should be, say, $1\frac{1}{2}$ higher in front.

(4.) *Methods of fixing Springs.*—Clips are preferred wherever possible. Bolts have the advantage of not slipping, but they often break off, and at the same time they weaken the spring to a considerable extent by the bolt holes; when a plate breaks, in three cases out of four it breaks at the bolt hole.

(5.) *Setting Axles.*—Too much care cannot be taken in testing the axles, both before they are fixed, to see that they and the wheels are true to the road, that the spokes are upright or plumb, that the pitch and foregather are not overdone, also, after they are fixed, to see that they are true with the body and run accurately, or follow. The wheels also should be tested to see that they are boxed centrally, that the dish is the same, and that there are no flat places in the tyres or felloes.

Testing Carriages in Wood and Iron. After a carriage is hung-on, and before it is painted, it should be tested, or, as we call it, *weighted*. This is done by loading it with rather more men than it is made for, to make up for possible luggage, and then for one or two of the occupants to stand up and work the springs up and down. In this way we are enabled to test the room between the bottom of body and axle, also between the wings and the wheels. If there is a pole it is then fitted in, and its height, and that of the splinter-bar and futchells, tested, then the front wheels are locked under the boot or body, and the space between the wheels and the arch is ascertained to be

sufficient and correct. Next we sway the body from side to side, as a further test to see that the wheels do not touch the doors or wings, and if there are lamps or head joints, or anything else likely to catch at the sides, they should be tried. Before the load is taken out, the doors should be tried and the head worked up and down, and when down to ascertain if the head slats allow room for the leather, and are clear of the wheels, and when up that it is square, and, if a landau, that it closes properly, and is free from twist, strain, or rattle If the levels front and back are now taken, and if, when the load is out, the springs come back and the carriage remains level, that is all we require in an ordinary vehicle In a perfect carriage something more is needed, viz., that each spring should deflect, or play along its full length, coming nearly straight with its full load, never back-over or to an uneven sweep. The shackles should all be clear of the scroll irons, and the axles should remain stationary while the springs are working, thus proving that the deflections of the springs are balanced. Also, the wheels should be absolutely fair with the body, and this is tested when the load is out by placing a long lath against the face of the front and hind wheels, say 6 inches from the ground, then if the wheels track, as they always should, and are fair, the lath should touch in four places, viz., front and back of each wheel, save only a slight allowance for foregather. The distance between the wheels and body at each side should then be tested to see that the body is true on its wheels. The steps, lamps, wings, dashers, seat-rails, etc., should all be examined carefully, and any standard sizes that the builder may have adopted, should be tested, as by testing only can a standard be arrived at and maintained.

BRAKES FOR RETARDING THE MOTION OF CARRIAGES.

The meaning of the word Brake is to retard, and not to break," or snap. The most powerful brake is one that etards the rotation of the wheel, but does not skid it; or, in other words, does not completely stop its rotation. A driver has much more power or command over his carriage when the wheels are still going round than when they are skidded; besides, a wheel that is frequently skidded, soon has a number of flat places in the tyre; and again, it is a heavy and unfair strain on the carriage parts, especially if they are made light.

The brake as used at the present day was first fitted to the mail-coaches about 1838-39, before which time the drivers had to depend on the "drag-shoe," or "slipper," and before that again, simply a chain or hook.

Varieties of Brakes. A brake is applied either at the tyre or nave of the wheel. The latter has to contend against the disadvantage of the leverage of the spokes, and is very rarely used; we therefore propose simply to consider the former. The two chief types of tyre brakes are known as the (1) "roller bar," or "tumbler," and the (2) "horizontal," "prop," or "scissor" brake. The first is the one recommended as giving most satisfaction, though the other is more easily fitted in some cases, such as landaus and broughams, where the hind wheels are close up to the hind door pillars, as the arms can be worked below the doors. Its chief disadvantage is that it constantly works loose. This is owing to the tendency of the wheel to carry the block down, and to raise up the lever end under the centre of the body; this strains the fulcrums, or pivots, on which the levers work, and also causes the joint bolts to wear, and produce a rattle; for the lever ends are apt to knock against the flooring-boards, or against one another, or against the connecting-rod. The brake block too does

not wear evenly, as one side is generally worn away before the other.

Friction of brake-block. The power of a brake depends, first, on the material of the blocks, and, second, on the leverage. For the first we have the formula

$$F = Pf,$$

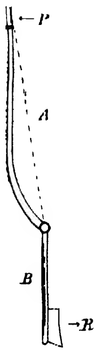


FIG. 21.

where F = the retarding power of the block when just about to slide on the tyre; P = pressure of the brake-block on the tyre, and f = tangent of the angle of friction, between the block and the tyre (that is, the inclined plane down which one substance will just slide over the other). Supposing P = 5 lb., and f = ·6, the value given in table, page 48, for wood blocks on iron tyres,

$$\text{then } F = Pf = 5 \text{ lb.} \times \cdot 6 = 3 \text{ lb.}$$

so that with a pressure of 5 lb. on the wood-block on the tyre, the wheel would be retarded with a force of 3 lb.

Power of the brake levers.—The rule for calculating the power of the leverage of the brake levers is the same as for a steel-yard.

Power × power arm = resistance × resistance arm,

$$\text{or, } P \times a = R \times b,$$

$$\text{or, } R = P\frac{a}{b}.$$

In fig. 21, suppose a = 48 in., b = 16 in., and P = 5 lb.,

$$\text{then } R = P\frac{a}{b} \text{ lb.} = 5\frac{48}{16} \text{lb.} = 5 \times 3 \text{ lb.} = 15 \text{ lb.},$$

showing that the leverage has increased the power three times. If a was doubled, or b halved, the leverage would be doubled, and the power increased six times.

The same process is continued if there are several levers. Thus it is possible to calculate the power of any system of levers, when the lengths of the arms are known. It sometimes happens that in a carriage like the mail-coach illustrated, the levers are not seen, and cannot be measured, if under the trimming, only the handle and brake-block. The way then is to calculate the power by measuring the distance each travels, viz., mark on the rack the distance the handle travels to move the brake-block, say, 1 in. If it should move through three times the distance, then the leverage of the brake increases the coachman's power in the same proportion.

Methods of applying the power.—We have supposed the brake to be worked by a hand lever,[1] it could be worked equally well by a foot-lever, screw, or ratchet. The foot-lever is favoured on the London 'buses, as it is easily applied by the driver, leaving his hands free for the reins and whip. The screw brake is chiefly used on the continent; it is very powerful, but slow in action. The ratchet is only used in a few cases; it is very handy for brakes worked by wire rope

Brake-blocks. This subject divides itself into three heads: (1), the materials of which they are made, and the retarding power of each; (2), the form of block best suited for the work; (3), the position of the brake-block for obtaining the best results.

(1) *Materials.*—Brake-blocks are made of cast and wrought iron, steel, wood, leather and india-rubber, the last-named being the material most used for first-class carriages. India-rubber of good quality has the greatest retarding power, leather comes next, and then wood, and

[1] The mechanical brake handle, of which there are so many varieties, does not increase the leverage of the brake. It is simply more easily adjusted, generally the notches of the brake-rack are smaller.

iron or steel, the two latter being very noisy. A good cheap block is made of wood, with leather nailed on

The co-efficients of friction are:

Materials.	Co-efficient of Friction.
India-rubber on iron (Offord's block)	·8 to 1·00.
Leather on iron	·33 to ·63.
Wood on iron	·35 to ·62.
Iron on iron	·18 to ·25.

(2) *Position of the block.* This is clearly a little above the centre of wheel, for it allows for the load bringing the springs down. If the block is fitted low down at first, it will bring the block below the centre of the wheel when the load is in the carriage, and unless the brake-rack is a long one the block will not catch the wheel.

(3) *Forms.*—As to the form of block, the great object is to select one of light appearance, yet sufficiently large to stand the wear. The common opinion of coachmen that the size of the block makes a difference in the frictional power of the brake is not confirmed by experiment. A 3-inch block and a 6-inch block give the same resistance, but, on the other hand, one lasts twice as long as the other.

The block should be easily movable for renewals, and adjustable, so that it may wear equally at the top and the bottom. The dove-tail block, to slide into a pan of standard size, meets the first requirement, but others working on a pivot with a spring, or with a rubber tube, like Downie's, meet both, and for many reasons are to be preferred.

Two-wheeled Brakes.—These can be made quite as easily and as powerful as any other brakes, but whether the blocks act on the front or back of the wheel, their action is to

transfer a portion of the weight of the cart and its load on to the horse's back, and for this reason they ought to be condemned. There are several methods whereby the weight thrown forward is counteracted, by moving the seat back, the axle forward, or hingeing the shafts, as in Casson's patent, but none of these plans seem perfectly satisfactory. If the balance is adjusted for the first notch of the brake-rack when the block just touches the wheel, it is thrown out by moving the brake handle into the next notch, as the smallest movement of the brake-block at once doubles the pressure, and it requires a considerable movement of the body to counteract it at the same time

CHAPTER III.

Drawing.—The importance of drawing generally to coachmakers. Freehand. Linear. Geometry and Projection.—Their application in carriage designing and drawing. The scale drawing.—The working drawing. The cant-board.

THERE are very few branches of manufacture in which a knowledge of drawing is not of value to those engaged in them, and it may safely be said that such a knowledge is not only important, but essential to the workmen who are employed in the six or seven different branches comprised in the term "coachmaking." Drawing trains the eye, the hand, and the memory, develops the faculty of observation, makes a man accurate, and increases his interest in his work, which he makes more perfect, both in regard to its utility and its artistic appearance. The apprentice who wishes to work as an intelligent being, and who undertakes the study of drawing, is not long in realizing that it bears a very close relation to his daily occupation. It is a gain to the manufacturer—and through him to the artisan—by reason of the accuracy with which the work is constructed, and the greater speed with which it can be produced.

It is not the aim of this book to teach drawing, but to indicate *what* the workman ought to learn. It is not asked that those whose hands have become heavy by the constant use of plane, hammer, and chisel, shall become refined draughtsmen, but it is now expected that those engaged in carriage manufacture, not only body-makers, but carriage-makers, smiths, and even trimmers and

wheelers, shall be able to produce, with tolerable exactitude, drawings of those things more intimately connected with their particular branch.

In recent technological examinations the body-maker has been asked, amongst other things, to "make a drawing of a brougham body, framed, but omitting the panels;" or, to "make a design for a lady's driving phaeton." The wheeler has been expected to draw a wheel of a given height in half profile; while the trimmer has been told to sketch outlines of cloth and morocco skins sufficient to trim a single brougham, and to show how to cut the materials with as little waste as possible.

Freehand drawing should be studied by everyone engaged in carriage construction A smith or a carriage-maker may be difficult to convince that it is at all necessary in his case, but one can see at a glance by the curve of a stay or a wheel-iron whether the smith who made them had a trained eye, and a knowledge of form and proportion, for such things are very often left to his own judgment. To the carriage-maker or carver, freehand is of value in such things as sketching and carving dub-ends and blocks (see fig. 22), which afford considerable scope for the display of good taste.

Practical geometry and projection should form the body-maker's next course of study. To the young body-maker with a sound knowledge of practical, plane, and solid geometry, the cant-board is not the bugbear it was to apprentices twenty-five years ago. As the knowledge of geometry has spread, so has the cant-board of the coach-maker been improved up to the present time. Its advantages are apparent even to the younger apprentices, who readily realize that it saves both time and material.

In former times the workman took his work to pieces over and over again in order to find measurements and bevels as he went along, and even when a knowledge of the

construction and uses of the cant-board had spread amongst the more experienced body-makers, they purposely mystified the younger generation in regard to its production, and an apprentice could only gain information either as a favour or by subterfuge.

The making of rough sketches of actual objects should be practised by everyone, for it is a valuable acquisition when one sees something that is worth remembering or

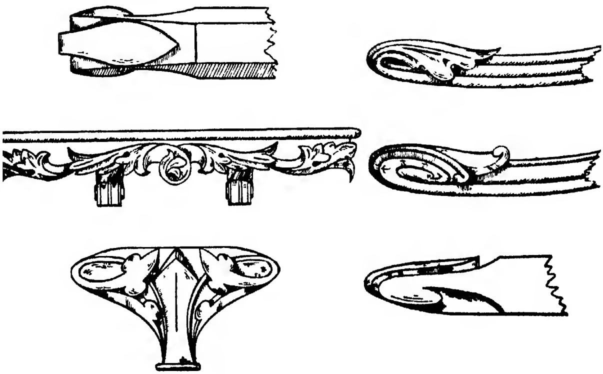


FIG. 22.—CARVED DUB-ENDS AND BODY-BLOCKS.

copying. The object should be measured, and the dimensions plainly written in figures for future use; with practice it becomes an easy matter to make a scale or full-size working drawing from such rough sketches. The ability to make such sketches accurately and rapidly is most important to the draughtsman who makes the scale drawings which are submitted to possible purchasers of carriages, and who, when the style of carriage has been definitely decided upon, proceeds to make the full-size drawing for

the workmen. To the carriage draughtsman freehand is all-important, because there are many little details, such as curves, which must be put in by hand; and it is very often easier to draw the arc of a circle in this way than to spend time in finding the centre to draw it with the compasses.

The full-sized drawing for the use of the workmen is usually prepared from the small scale drawing, but the method of making it, and the amount of detail given, varies very much. The more complete the drawing, and the greater the detail, the more accurate will be the work In many shops the body-makers have nothing more to guide them than a side view of the body and two or three cross sizes chalked on the board, while the carriage-maker finds nothing more than the distance of the body from the ground and two circles showing the heights of the wheels Such things as the depth of the beds, compass of springs, position of axles, etc., must be worked out by the men themselves, and the result is that alterations are very often necessary after a carriage is hung and weighted, entailing both expense and loss of time; whereas, when a good drawing is used, the manufacture of the wheels, springs, axles, etc., may be proceeding while the body is being built.

Fig. 23 is given with a view to impart some practical knowledge of the manner of preparing a working drawing, and it shows very clearly how much a knowledge of geometry and mechanical drawing will assist the young body-maker in reading a working drawing of this kind. No. 1 is a side elevation of the body; Nos. 2 and 3 half back and half front views; No. 4 shows the laying out of the fore-carriage and the locking of the wheels, so that the tops of the wheels shall not touch the arch panel as they turn under when the carriage is loaded; No. 5 is the body-maker's working drawing, known as the "Cant," which combines the side elevation with the top plan, and the

inside plan with the cross sections, showing the length, breadth, and thickness of each piece of timber in the body.

In making a working drawing like this some draughtsmen commence by drawing their vertical lines, such as the inside of the pillars, the extreme points at the elbows, and the front and back of the boot. Others commence with the horizontal representing the ground line, and from this put in all horizontals before drawing their vertical lines; but these are mere matters of convenience.

In No. 1 we draw the base line, and upon it erect a perpendicular, which will form the inside of the hind or "hinge" pillar. We determine the height of the front and hind wheels, the compass of the springs, the depth of the fore-carriage, the height from the ground to the step, and from the step to the top of the rocker. From the base line measure on the perpendicular the distance from the ground to the bottom of the body, the height of the bottom-side or rocker, the height of the seats, the depth of the door panels and quarters, and the extreme height of the body. These are all horizontal lines, and upon them we can lay off the width of the door and the widths of the front and hind quarters. The curved lines of the body may now be drawn in, and should always be produced in the first case by very lightly drawn freehand lines, because good curves are easily produced in this way, and when satisfactory lines have been made they may be gone over with wooden curves made to fit them. From the hinge pillar we measure backward the distance of the hind axle, and drop a perpendicular, and with a centre on this perpendicular we draw a circle the height of the hind wheels, then draw in the springs and pump handle as shown. The lines of the boot are next worked in like those of the body, but to prove the correct height of the boot and the arch panel we must produce a diagram like No. 4, to show that the wheels will clear when the carriage is loaded. The dotted lines show the method

of testing this clearance when the wheels are turned at right angles, and when half way under, allowing two inches for the settling of the body when the load is in.

No. 5 is the "cant" of the body, the cross section of the pillar being given in the doorway for the sake of convenience. This view gives the turn-under and from it the body-maker marks his turn-under pattern and finds the position of the glass frames when they are dropped down into the door. The line A B is called the base and forms the edge of the cant-board, and is of course the centre of the body, both sides of which are alike. From this line A B draw lines C D, E F. C and F represent the front and back of the body, while D and E show the width of the door. Measure the width of the body along each of those lines, and through points F, M, N, C draw a curve showing the side sweep of the body. Next draw the cross section of the hind standing pillar C, G, H, I, and draw a line down from the cant rail following with perpendiculars C, G, H, I, showing the turn-under. Draw the lines C, G, H, I until they cut the edge of the body, and from the points thus obtained drop perpendiculars, and from the centre, C, mark off the distance C C, equal to C C, and the other points in the same way, repeating the process at the front, J, K, L, F. The dotted lines, which are measured from the cross section of the standing pillar, indicate the turn-under at the points marked. To ascertain that the head in falling will clear the front seat, we draw the dotted lines shown in the side elevation.

CHAPTER IV.

THE WOODS USED IN CARRIAGE-BUILDING.

The various Timbers—Native and Foreign—used in Coach-making. Ash, Oak, Elm, Mahogany, Birch, Walnut, Hickory, Lancewood, Whitewood, Cedar, Sycamore, Poplar, Yellow pine, etc.—Specimens of Timber at the Imperial Institute—The Natures and Properties of the various woods. Their conversion and seasoning. Marking timber for sawing.

OF the coachmaker's raw materials timber is the most important, and it is desirable that the young coach-maker should not only be able to identify certain woods at a glance, but that he should be familiar with their relative qualities such as strength, toughness, stiffness, elasticity, weight and durability. The majority of the numerous woods employed in carriage construction are hard woods, the principal grown in the United Kingdom being ash, oak and elm. Next in importance come mahogany, cedar, walnut, birch, sycamore, whitewood, poplar, yellow pine, lancewood and hickory.

Naves of American rock elm, spokes of American oak and hickory, and bent rims of hickory have been largely imported into this country for many years, and have thoroughly established themselves, but of such woods as Australian ironbark for spokes, and Jamaica fustic for naves, very little can be said until more extended tests have been applied to them by British builders. It has, however, been proved beyond question that for hot climates fustic naves and hard dense oak spokes give satisfactory results.

At the Imperial Institute there is a splendid collection of specimens of Colonial timbers, many of them apparently suitable for carriage, and particularly wheel, construction; and with a sufficient degree of enterprise on the part of the Colonial timber merchants and British importers, there should be no difficulty in bringing them into competition with the American wheel timbers now used so largely.

For the framework of a carriage body we require a strong, tough, hard and fibrous wood without great heaviness, and we find those qualities combined in the greatest perfection in the hedgerow ash for which there is a great demand in England. Strength, toughness and elasticity are the distinguishing characteristics of ash. It is a durable timber when protected from the weather, and, consequently, when well seasoned and used in the construction of a carriage body that is properly painted, it has a long life. The ash is not a large tree, as we seldom see a plank more than 24 inches wide, but it is unlike many other timbers, as much of the sapwood may be used, and almost the full width of the wood is sound and at our disposal. Ash lends itself readily to steaming and bending.

The older timber may be used for body framing, but that for under-carriages, and especially for poles, should be young, as we require an exceptional degree of toughness and elasticity. For wheel-making, ash is said to be best when about fifty years old.

American ash is used for footboards and for varnished panels and dashers; it is light, and shows a good figure under varnish, but it has neither the strength nor the toughness of the English timber, as it is forest grown, but is most useful for the purposes indicated, and for making driving boxes. It is liable to rot quickly when exposed to wet.

It is essential that the principal coachmaking timbers

should possess great transverse strength, and tests to ascertain this are the best for deciding the suitability of woods for carriage construction, pieces of the wood being tested by being supported at each end, and loaded in the middle until they break by transverse strain, care being taken to notice the weight put upon the specimen, and the amount of deflection caused by the load up to the breaking point. Sir John Anderson has tabulated experiments made by Barlow, Tredgold, and others, to ascertain the transverse strengths of various timbers. In the case of ash the calculated weight necessary to break a piece 1 foot long by 1 inch square, supported at each end and loaded in the middle, varies from 595 lb. to 810 lb.

The *British oak* is the most important of our wheel timbers, but it is seldom used in body-making, except for boot-bottoms, cab bottom-sides, glass frames, and for the panels of varnished carts, in which position the silver grain shows up prettily through the varnish. Oak is hard, rigid, and tough, while for strength it is unequalled by any of the home-grown woods. For ages it has been esteemed for its durability under the most adverse conditions.

The Russian, Polish and German oaks which are imported into this country under the names of "Dantzic," "Riga," etc., are unsuitable for wheel construction, as they possess much less strength than the British timber, being grown in forests, and sheltered from sun, wind, and rain. Experiments by the authorities before mentioned showed that the breaking weight of English oak 1 foot long by 1 inch square, supported at the ends and loaded in the middle, varied from 420 lb. to 964 lb.

Elm is employed principally for naves, footboards, seats and boot-sides, and occasionally for panels in varnished work. It is durable when kept dry, or when completely submerged in water, but it is soon destroyed if kept

alternately wet and dry. Elm is a hard, fibrous wood, very difficult to split, and consequently it is the most suitable native wood for naves, which have to bear a greater strain than any other part of a carriage. The wych elm, which is more commonly grown in Scotland and Ireland than in England, is esteemed the best; but with all its good qualities it is surpassed by the Canadian rock elm, a slow-growing tree which yields a solid, highly fibrous, beautifully coloured wood, which during recent years has been largely imported into this country for naves. It is now being used for carriage poles, but its superiority to ash for that purpose has yet to be established. The Dutch elm is much inferior to the wych, is darker coloured, and more inclined to cracks and shake. The breaking weight of English elm of the dimensions before enumerated is given at from 337 lb. to 540 lb.

Birch, which we use principally for footboards, boot-sides, wings, and for varnished work, is a prettily marked, close-grained, heavy wood, but that grown in this country is rarely used, being of very small dimensions compared with the wood we receive from Canada.

Sycamore, which is persistently and wrongly called plane-tree by many people, is one of the very few home-grown woods which the coachmaker can obtain in good widths, and as it is a prettily marked, clean, and fairly durable wood, it is very useful where no particular degree of strength or toughness is needed. It is liable to the attacks of worms.

Poplar is but sparsely used by coachmakers in this country, and might be more frequently utilized for bent sides, etc. It is a soft, white-coloured wood, the principal recommendation of which is its cheapness and the facility with which it may be bent. The Arbele, or white poplar, is the best, and sometimes yields faultless planks

thirty-six to forty inches wide, by fifteen or twenty feet long.

Mahogany.—Of the various kinds of mahogany imported into this country there is none so suitable for carriage panels as that called Honduras mahogany, or baywood. It has not the beautiful markings of the Spanish or Cuban timber so dear to the cabinet-maker, but it is straight-grained and of larger dimensions, boards sometimes reaching a width of thirty-six inches. It is plentiful and fairly moderate in price. Protected from the weather it is very durable. It is curved and bent with facility, and above all it holds glue well, and gives a better surface for paint than any other timber yet used for the purpose of panelling.

Cedar.—We occasionally find this wood used instead of mahogany, the plainer kind of which it somewhat resembles. It has a straight and open grain, is brittle, and can only be used for common or covered work, as owing to its porous nature, paint and varnish is absorbed, and panels soon lose their lustre.

Black Walnut, which we employ for varnished work, is principally obtained from Canada. The walnut used by coachmakers is a straight-grained wood of greyish-brown colour, with little or no figure, and is unsuitable for bent panels—unless the curve is not very pronounced—but for straight work it is an admirable material, and looks well when varnished.

Whitewood, which we obtain from Canada, is not so widely used for panels in the United Kingdom as it is in America, where it occupies a position similar to that held by mahogany here. The best kind is a yellowish white or canary-coloured wood, with an uniform grain, remarkably sound, and easily worked. It is frequently met with forty inches wide, and is most useful for bottom panelling, seat-boards, etc., but in long wide panels it has a great tendency to buckle, and spoil the look of a job.

Yellow Pine.—The pine most commonly used in our trade is the North American yellow pine, which must not be confounded with the knotty, white spruce or fir used by carpenters and builders. Yellow pine is a light, soft, clean, straight-grained wood, which is easily worked, and, compared with other woods of a like nature, is remarkable for the absence of knots. Some of the pines and firs are so resinous as to cause much trouble in working, and some are so stringy or woolly in the grain that they can scarcely be brought to a smooth surface, however much they may be dressed, but yellow pine is very free from this defect, and, moreover, it is cheap, plentiful, and holds glue well.

Vancouver Pine and Kaurie Pine.—These two excellent timbers of a similar nature are both used by coachmakers. They are clean, straight-grained durable woods, giving good surfaces, but the former is somewhat heavy and inclined to split.

Lancewood.—For the shafts of two-wheeled carriages we know of nothing to equal lancewood, a strong, heavy, canary-coloured wood, with a close, straight grain, remarkable for its elasticity. Because shafts so often snap off short when an accident occurs many people believe lancewood to be deficient in fibre, but the short break so frequently seen is caused by damp and moisture getting into the wood, where holes have been bored, or where the shafts are covered with leather. Thus, a lancewood shaft usually breaks either at the bar or at the breeching parts.

Lancewood spars, which are imported from Jamaica, usually yield three or four shafts each, and experienced men say that the heart should always be observable in the spar, or it is too large. The wood now so commonly sold and used under the name of Dagamé lancewood has neither the strength nor the elasticity of the genuine article. It is softer, and not nearly as rich in the colouring.

Hickory.—This is the principal American wheel-wood, and is imported into this country both in ready-made wheels and in ready-made spokes as well as logs. It is a highly prized timber, and justly so, for it is remarkably tough without being unduly heavy, and it is consequently very suitable for light wheels. There is, however, much difficulty in Great Britain in obtaining what the Americans call *first grade hickory*, and much inferior stuff is sent to England. Hickory is not so strong as English oak, and it is very liable to rot at the spoke tenons, if they are not well protected by paint where they enter the nave, and the rim.

The same wood is occasionally used for shafts, but of course it costs more than home-grown ash without a corresponding superiority in strength, and without the elasticity of lancewood Now that the timber trade has reached such vast proportions, and there are importers and dealers in almost every large town, the question of seasoning is not of so much importance to the manufacturer as it used to be. The coachmaker can now obtain any of the ordinary woods ready seasoned, and in almost any quantities. This is a great advantage to one whose operations are not conducted on a large scale. He pays more for it, but he is relieved of all expense and loss in buying, converting, and seasoning round timber, as he has no slabs and waste. In the more extensive coach factories, however, where large quantities of wood are used, and where firms are jealous of the character of their productions, the purchase of timber in the round, its cutting and conversion are a part, and a very important part, of the business.

The conscientious coachmaker takes care that his timber is not only seasoned, *i.e.*, made durable by being rid of the vegetable matters which would destroy it, but that it is as dry as possible, for, in our climate, wood can never be made to remain perfectly dry. It will absorb moisture whenever the atmosphere is humid, however slightly, and it will

shrink again as readily when the air is dry and warm, and if that shrinkage is in any way prevented by the edges of a board being pinned or screwed, then the wood will crack. This fact shows us the importance of having wood not only seasoned, but of having it as dry as possible. When a tree has been felled it should be raised on blocks, so that if it lies any length of time it may not absorb moisture from the ground.

Different sawyers have different opinions about the best way of treating timber after felling, but all are agreed that the slower the seasoning process, the sounder and tougher the wood, and the less it will warp and split after being planked. Some sawyers prefer to skid the log from the ground, and to leave it lying in the timber-yard until the bark drops off, when they commence to plank it. Wood treated in this way is remarkably sound, and in many cases much of the sapwood can be used, as it partakes more of the nature of the heart-wood than is the case when a tree is planked soon after felling. Elm and cherry wood appear to be considerably benefited by this treatment.

Fifty years ago it was a common practice in country districts to cut up wheel timber and then place it in running water for two months, after which it was stacked in sheds and air dried. This excellent plan used to be followed at the royal dockyard, and the result was excellent timber, which dried quickly and which afterwards proved to be particularly sound. Such a plan is of course impossible in many places, and for various reasons it has been abandoned where it was formerly practised.

After cutting timber our chief object should be to give it plenty of air without draughts, and without a strong light, and to protect it from the sun and rain, so that the drying may be steady and regular.

Ash planks are best placed in a shed, standing on their edges in racks, and they cannot be said to be fit for use

until they have stood one year for every inch of their thickness. This is regarded as a rule by many experienced men, but it is a very rough one, and it cannot apply to all timber, as there is so much difference in the character of our woods. It requires much experience to tell when wood is dry enough to be worked, for every apprentice knows how a board will shrink if it is planed over and left lying a week or two; or how a lancewood shaft, which has not been allowed to dry thoroughly after the steaming and bending process, will shrink, and often open up in small cracks after the outer skin has been taken off with a plane.

Panel and other thin boards are of course much more readily seasoned than the heavier timbers, and as dry and well-seasoned wood of a very high class can now be obtained from respectable merchants, there are very few coachmakers who go to the expense and trouble of planking their own mahogany and walnut logs.

Wheel-wood ought to be cut as near its ultimate dimensions as possible, as it dries quicker. Naves, after being cross-cut to the proper length, and bored, should have some of their superfluous timber taken off to facilitate drying, and should be placed regularly in rows, separated by strips of wood, while spokes and felloes should be stacked and left two or three years before being worked up. The shed should be dry and airy, and the light should be subdued.

The bending of boards and panels is a task that every apprentice approaches with diffidence, and even amongst older men we are sometimes struck by the fact that a knowledge of the direction in which wood shrinks would be of considerable value in saving both time and material.

This is particularly the case at the present time when so many bent panels are used in two-wheeled work. Some of the timber used for this purpose is not only thicker than

ordinary panel board, but it is also somewhat hard, so that the selection of a mild piece of stuff from that part of the log which will most readily bend to the required curve is a very important matter.

It must be borne in mind that a plank or board shrinks very little in the direction of its *length*. Its contraction is chiefly in the direction of its *width* and its *thickness*.

This contraction varies, because a tree always shrinks in the direction of its circumference, or, in other words, the wood shrinks more on the outside than at the heart.

Fig. 24 will explain this fact.

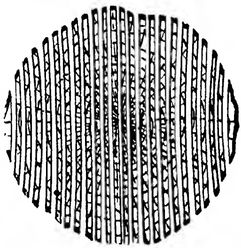


FIG. 24.

The plank or board in the centre is not inclined to bend in either direction. It is the worst that can be selected for bending purposes, but the best for a flat surface. In seasoning it becomes thinner at the edges than at the centre, owing to the way in which the tree shrinks. The other boards are inclined to bend away from the heart, and the further they are from the middle of the log the more they lose in breadth but less in thickness.

If we clean up the end of a board and examine it, we may tell from what part of the log it has been cut, and in bending it by wetting one side and exposing the other to heat, either at an open fire, a steam-pipe, or a half-round casting heated by gas jets, we can avail ourselves of the natural tendency of the timber, and gain our object with less labour and less waste than if we go to work without due consideration. This is particularly the case with the thick panels before mentioned. They should always be bent to a template, and the greatest care must be taken to

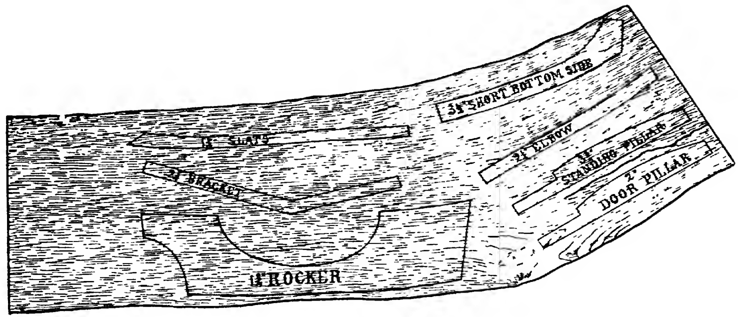


FIG. 25.— LANDAU FRAMING.

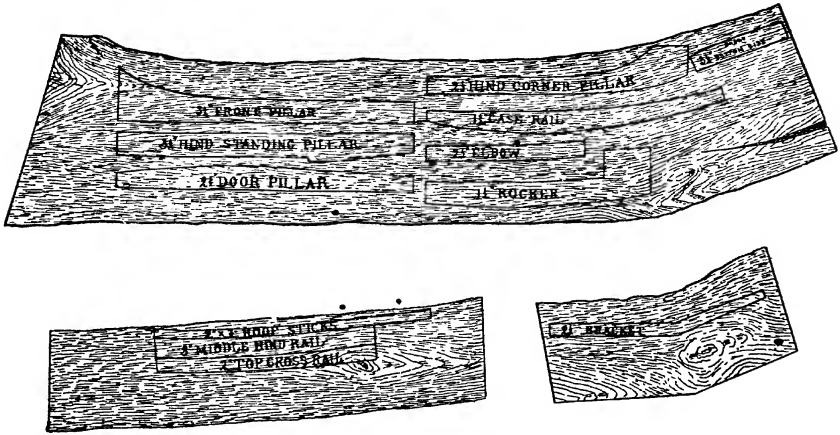


FIG. 26.—BROUGHAM FRAMING

avoid burning the concave side; for no matter how we may afterwards treat a burnt panel, it never gives a good surface for the paint.

Questions recently set for candidates in the City and Guilds of London Institute examinations, show that the question of *waste* is now receiving the attention that it merits. Coachmakers' timber is a valuable commodity, and economy in cutting must always be kept in view. There must, of course, in every factory, be a certain amount of waste, but it should be reduced to a minimum by carefully marking and cutting the plank.

In some curved pieces of timber it is essential that the coachmaker should preserve the grain throughout the entire length, and this entails some loss, but there should always be a careful selection of every piece or end that can be worked up for other purposes. Figs. 25 and 26 are diagrams made to illustrate the marking out of the body framing of such a landau as fig. 23, and a brougham like fig. 2. In marking the door pillars we turn the outside to the heart of the plank, so that any tendency to bend may serve to preserve the spring of the doors.

As candidates in technological examinations are frequently requested to calculate the quantity of wood for certain work, they should bear in mind that a little elementary arithmetic will assist them, and they should not forget that a piece of timber 3 in. thick will not make three boards 1 in. thick; because the two saw-cuts necessary to make the three boards, and the subsequent dressing at the bench, will reduce the thickness of each board by fully one-eighth inch. The simplest rule for calculating such measurements is duodecimal multiplication, *e.g.*, the superficial contents of a board or plank, say 10 ft. 6 in. by 2 ft. 6 in., is found thus:

10	6	
2	6	
21	0	
5	3	0

Superficial contents, 26 ft. 3 in. 0 parts.

To find the solid contents of a plank, multiply the length, breadth, and thickness together. For a piece of wood of varying width, take the average width.

CHAPTER V.

IRON, STEEL, ETC.

The Properties required in carriage construction. Ductility.—Fibre.—Tenacity. Welding.—The various qualities and sections used by the coachmaker.—Steel and iron edge-plates.

THE need for the iron and steel employed in carriage construction to be of the best possible quality is imperative The coachmaker's iron ought to be ductile, fibrous, tenacious, and easily welded, for a modern carriage is a light structure, on which the iron parts are reduced to the smallest possible dimensions, and if the metal does not combine all the properties enumerated, grave accidents and loss of life may result.

The iron must be ductile in order that the coachsmith may—without injuring it—draw and bend it into those curves and angles to be seen nowhere in such perfection as in a well-ironed carriage. It must have fibre and tenacity to resist fracture, so that even when overloaded, or strained, under exceptional conditions, it may bend, but not break. It must be easily welded, for in coach-smithing welds are numerous, and sometimes difficult to make, and this in places where strength is of the greatest importance.

We can obtain those properties only in iron of the best quality, manufactured by firms whose productions are known to be reliable, and there are a very large number of such firms in this country, principally in Yorkshire and Staffordshire.

Speaking generally, manufactured iron is divided into three classes, "merchant iron," "best," and "best best,"

but many firms make a specially good quality called "treble best."

Ordinary "merchant" bars are those rolled from faggots of puddled bars. "Merchant" iron, when cut and rolled, gives "best" bar; while faggots of "best" bar, when rolled, give "best best" iron.

Ordinary "merchant" iron ought not to be used in carriage construction. It may be all that is necessary for a variety of purposes, but it has not been rolled sufficiently, and consequently has not the fibre requisite for the purposes of the coachmaker, who needs either "best" or "best best" iron; the latter for anything that has to bear strains.

A practical acquaintance with the iron produced by good firms, and a knowledge of different brands are the only things to assist one in choosing iron suitable for various purposes.

More than twenty years ago in the City and Guilds of London Institute examinations candidates were requested to "*write down the marks stamped on the iron and steel generally used for the best carriages*," and a more difficult question could scarcely have been put to an average workman, for, unless he had worked in various parts of the kingdom he could scarcely have a practical acquaintance with the many good brands in use by coachmakers. The following are a few of the brands and marks used by well-known firms, but there are, of course, many others which might fairly be placed in the same list if space permitted such an enumeration.

It is to be noted that many ironmasters employ a crown for their trade mark, adding letters to indicate a particular brand.

L W.R.O.	The Earl of Dudley's Round Oak Works, usually called "Lord Ward" brand.

B.B. & Co.
Best KM Kirkstall. Best Best KBM Kirkstall. Best Best Best (XF) Kirkstall. — Kirkstall Forge Co. Leeds.

S I Co and $X^{S}L$ — Shropshire Iron Co.

B & B J — Benjamin Bunch and Sons, Walsall.

B. O. — Bowling Iron Company, Bradford.

B B H — Barrow and Son, Tipton.

S. C — Bradley and Company.

S. C. — Williams and Sons, Wednesbury Oak.

TUDHOE
Tudhoe Best
Tudhoe Best Scrap.
Weardale
Weardale Steel
WEARDALE STEEL SIEMENS
— Weardale Iron Company, Spennymoor.

SHELTON
GRANVILLE
— Shelton Iron Co.

TRADE MARK. Wm. OXLEY & Co ROTHERHAM TRADE MARK

Wm. Oxley and Company, Rotherham.

In former years Swedish iron, which has a deservedly high reputation, was much in favour with coachmakers, because of its remarkable purity and toughness, but it is not now so generally used except for converting into spring steel. The two best brands were probably the Dannemora and Persberg. Dannemora is stamped with a hoop L or O O (double bullet), and other good qualities are J. B. Crown, Hoop S, etc

The sections of iron and steel used by the coachmaker are not very numerous. Except in isolated cases he does not employ the angle, channel, and tee forms used by the engineer, the shipbuilder, and the architect.

The sections commonly used in the coach-factory are:

ROUND. TRUE HALF-ROUND. CONVEX TYRE. OVAL. FEATHER-EDGE.

SQUARE. FLAT. FLAT TYRE WITH ROUND EDGES. FLAT TYRE WITH ONE ROUND EDGE.

There are also hoop iron and thin sheets or plates. A plate is a piece of flat iron more than nine inches wide. If it is very thin, it is called a sheet. The other forms, when less than $\frac{1}{2}$-inch section, are called rods.

Much of the steel now used is made by the Bessemer,

Siemens-Martin, and other "open hearth" processes. The Bessemer method of production is the reverse of the cementation process. In the manufacture of spring steel by cementation, bars of iron of good quality—say of Swedish or Russian iron—are subjected to great heat in contact with charcoal, in fireclay boxes, the length of time depending upon the degree of steeliness to be imparted to the metal. As the amount of carbon absorbed by the iron varies in the different bars, it is necessary to break them up and sort the pieces. They are then melted, and afterwards rolled into bars. Good English brands are used in this way, and although they may not be so chemically pure as the Swedish iron, they are much more uniform in texture, because they are made with better machinery.

In the Bessemer process the pig iron is melted, poured into a vessel called a "converter," and subjected to an extremely strong current of air, the oxygen of which burns out the carbon and leaves the iron comparatively pure. To make steel from this iron, the manufacturer adds a certain amount of *spiegeleisen*, which is a compound of iron, carbon, and manganese, the quantity varying with the degree of steeliness he wishes to impart; the metal is then cast into ingots. This process is much cheaper than the older methods of iron and steel manufacture, and the steel is so good that it has displaced wrought-iron in many ways, and its employment goes on increasing.

The thickness of coach-spring steel is expressed in gauges Nos. 1, 2, 3 and 4, which are respectively ·312 in., ·284 in., ·259 in., and ·239 in. thick.

During the last twenty-five years the subject of the weight of carriages has received the most careful consideration of British coachmakers, and for some time it was asked, "In what parts of a vehicle can steel be substituted for iron, so as to give greater lightness with the same strength?"

Seeing that good mild steel has an *elastic* strength of something like forty per cent. more than iron, it was thought it might be employed with advantage for edge-plates, which are the heaviest pieces of iron-work in a body, and in which the greatest saving of weight might be effected. Steel body-plates measuring only about three-fourths or two-thirds of the sectional area of the iron plates were tried, but the result was not satisfactory. Many coachmakers overlooked the fact that it is not *strength* alone we need in an edge-plate. We require great *stiffness* in order that the plate may not bend when the load is in, and cause the pillars to nip, making it impossible either to open or close the door.

In that respect steel is no better than iron, and, practice having demonstrated the fact, some builders were led to reject steel altogether, where they might have employed it with very valuable results. On the other hand, there are some coachmakers who overcame the difficulty by giving the requisite stiffness where it was needed, and they would not now revert to the use of iron.

Other metals and alloys do not enter largely into carriage construction.

BRASS, an alloy of about two parts of copper to one of zinc, is employed for door-plates, axle-caps, etc. It is used for plating handles, beading moulding, rails, etc. Such fittings as handles and rails, in which strength is necessary, are made of iron, upon which sheet brass is plated by means of solder.

COPPER forms the body of beading and moulding, which is filled with solder. It is also used for lamp linings which are plated with silver. Bands of sheet copper are sometimes used for repairing shafts.

GUN-METAL, an alloy of about ninety parts copper to ten of tin, is used for axle-nuts and colletts, and for the sliding blocks of the movable bodies of some dog-carts.

SILVER is used for plating handles, lamps, beading, mouldings, and other parts.

GOLD is employed for the same purpose, but only in exceptional cases.

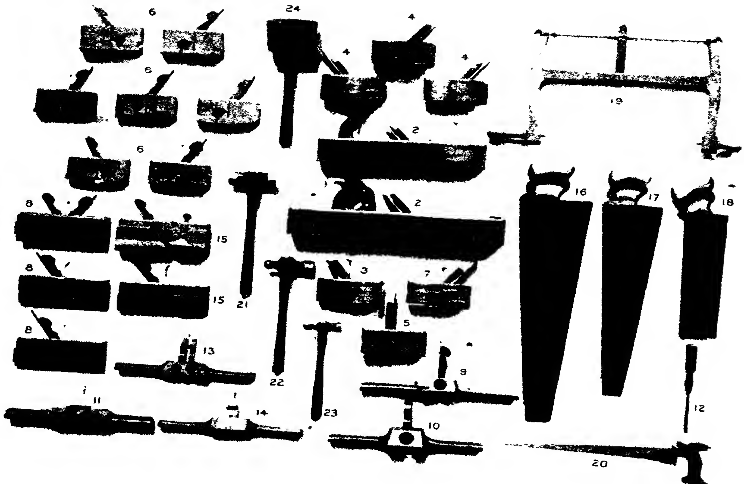


FIG. 27.—BODY-MAKER'S AND CARRIAGE-MAKER'S TOOLS.

[To face page 75.

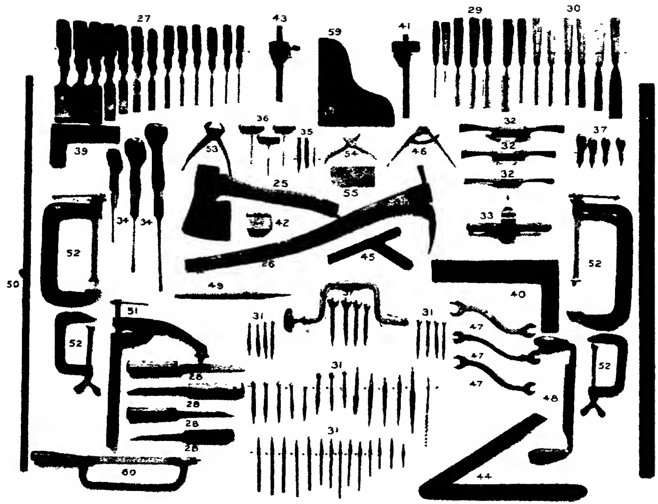


FIG. 27a. BODY MAKER'S AND CARRIAGE-MAKER'S TOOLS. [*To face page* 75.

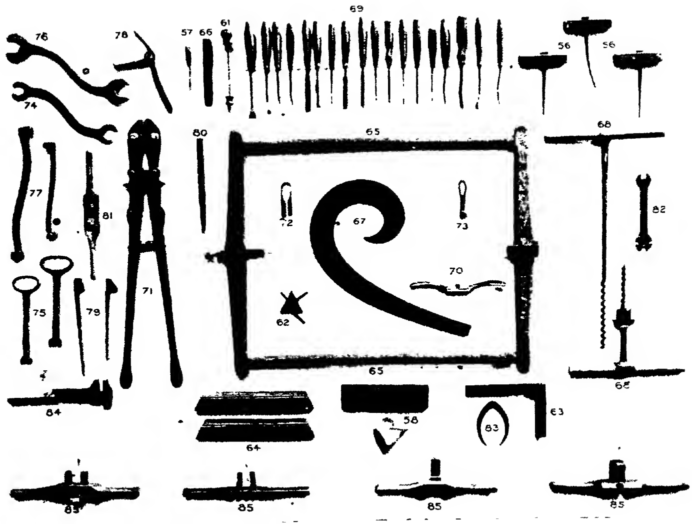


FIG. 27b.—BODY-MAKER'S AND CARRIAGE-MAKER'S TOOLS. [To face page 75.

CHAPTER VI.

CARRIAGE BODY-MAKING.

Body-maker's tools.—Framing joints used in body-making.—Getting out the stuff.—Parts of a landau framing.—The construction of a landau body. Framing. Fitting edge-plates.—Weighting the body.—Panelling.—Rounding in. Fitting locks and hinges.—Lever locks and lifts.—Fitting the head and head mechanism.—Victoria folding head.—Getting out the stuff for a Brougham.—Framing the body. Boxing out.—Panelling.—Hanging doors.—Noise in Broughams.

IN a book treating of coachmaking generally, and dealing with each of its various departments, it is obviously impossible to describe the making of every class of carriage body. A complete book on body-making alone would run into several volumes, and we must therefore avoid unnecessary detail and confine ourselves to the construction of the bodies of one or two typical carriages, such as a brougham and a landau. In these carriages we encounter most of the constructive difficulties to be found in the other forms, and having already dealt with the considerations which govern the shape and size of a carriage, we can now devote our attention to workshop routine. The body-maker's tools are a formidable collection, but everyone knows the value of a large number of first-class tools, and the advantage of keeping them constantly in good order, as this preserves their quality. Good work cannot be produced with bad tools, no matter how accomplished the workman may be.

Figs. 27, 27*a*, and 27*b*, represent the contents of a body-maker's and a carriage-maker's tool-chests.

The tools appertaining to body-making are:

1. Jack-plane.
2. Trying-plane.
3. Smoothing-plane.
4. Three compass planes.
5. Toothing-plane.
6. Set of T planes.
7. Door checking plane.
8. Two pairs of grooving planes, $\frac{1}{2}$ inch and $\frac{5}{8}$ inch.
9. Fence routers.
10. Boxing routers.
11. Side router.
12. Parting tool.
13. Beading tool.
14. Listing tool.
15. Checking filister.
16. Hand saw.
17. Panel saw.
18. Tenon saw.
19. Bow saw.
20. Keyhole saw.
21. Framing hammer.
22. Bolt hammer.
23. Pin hammer.
24. Mallet.
25. Axe.
26. Adze.
27. Chisels ranging from $\frac{1}{16}$ to 2 inches broad.
28. Mortice chisels.
29. Gouges from $\frac{1}{2}$ inch to 1 inch.
30. Flat gouges.
31. Brace and bits.
32. Spokeshaves.
33. Coach jarvis.
34. Screwdrivers
35. Set of punches.
36. Set of gimlets.
37. Set of awls.
38. Straight edge.
39. Set square.
40. Steel square.
41. Marking gauge.
42. Panel gauge.
43. Cutting gauge
44. Wood bevel.
45. Steel bevel.
46. Compasses.
47. Spanners.
48. Draw knife.
49. Files.
50. Rule.
51. Holdfast.
52. Cramps.
53. Pincers.
54. Pliers.
55. Scrapers.
56. Set of draw-irons.
57. Draw-points, straight and crooked for marking panels.
58. Oilstone and can.
59. Plumb square.
60. Saw for brass.
61. Fiddle drill.

62. Spider bevel.	65. Bettye saw.
63. Horizontal square.	66. Cold chisel.
64. Trying sticks.	67. Ram's horn sweep.

The coach body-maker uses a variety of framing joints that are rarely seen in either joinery or cabinet-making, and it is in the highest degree necessary that he should know how to make a framed structure so that it may offer the greatest possible resistance to the strains or weight it may have to bear. Unlike some other workers in wood, the body-maker must secure his joints from the inside so that they shall not show through the paint and varnish. They must be accurate, and the grooves must not be too

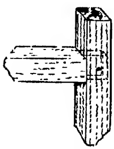


FIG. 28.

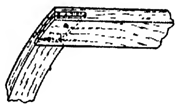


FIG. 29.

large for the panels, otherwise the mouldings will soon be rotted by water lodging in the open spaces.

The commonest and neatest of all joints in coachmaking is the mortice and tenon, of which there are several varieties.

Figs. 28 and 29 show the ordinary mortice and tenon in which it is necessary to drive a pin through both pieces, in order to prevent the tenon moving or being drawn out. This joint is used in a variety of ways in body-making.

Figs. 30 and 31 show the stub, or stump tenon, which is very short, and does not go completely through. We use it in framing the waist rails of our doors, and as we can then screw it from the face of the pillar we avoid using mortice

pins, which would be seen from the outside. It is also used at the foot of a gig pillar. The lap and tenon joint (fig. 32) is principally used by carriage-makers in such things as the framing of a draw-bar into the shafts of a two-wheeler. When a mortice must be cut to one side, the

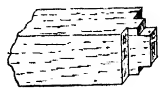


FIG. 31.

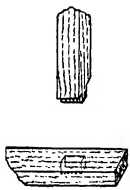


FIG. 30.

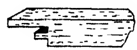


FIG. 32.

tenon has only one shoulder, and is called "bare-shouldered." It is necessary that mortice and tenon joints should be tight and accurate; therefore in sawing we cut outside of the gauge marks in one case, and inside the marks in the other. The other principal joints are·

The lap joint (fig. 33), which we use for letting in battens, is merely a recess equal in width and depth to the piece to be inserted. If the wood is not thick enough to allow a cut of the full depth, we cut away a portion of the inserted batten or rail in order to obtain a flush surface.

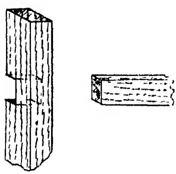


FIG. 33.

The half lap (fig. 35) and the stopped lap (fig. 34) are two joints much commoner than formerly. At one time half lapping was only practised in good work, when the wood was not thick enough for mortice and tenon, which were considered much superior; but it would be idle to deny

that in some cases the half lap, although it is easier to make, forms a stronger joint than the mortice and tenon.

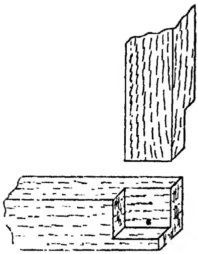


FIG. 34.

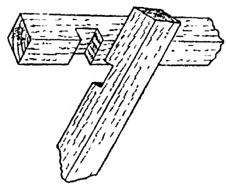


FIG. 35.

The mitre joint (fig. 36) is very little employed in coach-making. We only use it in such places as the junction of a brougham top quarter panels to hide the end grain, or in the top boot-arch panel.

The dovetail (fig. 37) is only employed in fixing the

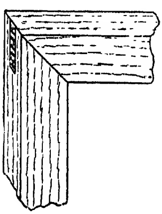


FIG. 36

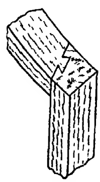


FIG. 37.

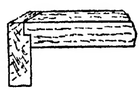


FIG. 38.

circular front of a brougham to the pillar top in making driving boxes, or *exceptionally* in framing the bottom side

to the standing pillar. It is a joint of many varieties, that illustrated being the ordinary plain form.

The rebate or rabbet (fig. 38), is merely a ledge or bearing for bottom boards to rest on.

As we have seen in Chapter III. the body-maker must construct his patterns and sweeps from the working drawing, fig. 23. For those patterns he employs thin pieces of soft wood or mahogany. They are used for marking the pillars, rockers, bottom sides, elbows, brackets, front and hind rails on the timber in the saw-mill, technically known as "getting out the stuff." He is usually allowed to choose his timber, and, for reasons indicated in the chapter on timber, should commence with the thickest plank, as the spare wood can be worked up for smaller pieces.

The diagrams (figs. 25 and 26) show how the pillars and other principal timbers of a landau and a single brougham should be marked on the plank to get the best results. Those examples are shown on planks taken at random from the wood in the saw-mill. In curved pieces, for the sake of strength, we endeavour to preserve the grain throughout the length of the piece, but this, of course, is not always possible, and the existence of a "shake" like that in the plank on which the landau framing is shown will upset our calculations, and require all the sawyer's skill to make good use of the sound wood. At this stage the careful body-maker will collect his panel, roof, bottom, and other boards, and either dress them up, or put them aside in a moderately warm place where he can readily lay hands upon them when necessary; moreover, this plan prevents a lot of annoyance from shrinkage afterwards.

It is possible to purchase the framing of an ordinary carriage, ready cut, seasoned, and at very moderate prices; but whether the body-maker is provided with his timber in that way, or marks out his framing in the saw-mill, he needs for a landau:

4 Standing pillars,	4 Bottom sides,
2 Rockers,	2 Boot sides,
2 Brackets,	4 Door pillars,
4 Elbows,	4 Pillars,
2 Door rails,	2 Bottom bars,
2 Door bottoms,	2 Seat rails,
1 Back top bar,	2 Boot bars,
1 Top boot rail,	1 Back bar.
1 Seat framing,	2 Case rails,
8 Hoop sticks,	8 Slats.

We must use some discretion in the selection of our framing timber, and choose a light wood for such parts as the door pillars, while for the hind bottom sides, to which we bolt the pump-handles, and for the boot bottom sides, we require hard, strong ash. For instance, the boot neck piece and rocker of the victoria (fig. 1*a*) have to bear some very severe strains, and the wood should therefore be strong and tough, and the grain ought to run with the curve as near as possible. The wood is then cut up by the sawyer with the circular, vertical, or band saw, as the shape of the piece may necessitate, the requisite allowance being made for bevels and dressing up.

The body-maker next faces his stuff, or, in other words, he gives the pieces a perfectly flat side, and from that true surface he squares his wood and gauges all curves, bevels, etc., shown by the cant-board. For this reason it is essential that the face sides should be absolutely true, that it should be specially marked, and that it alone should be worked from. After the dressing of the stuff comes the very important work of marking off the joints, and it is here that the advantage of thoroughly understanding the working drawing is most apparent. The man who has this knowledge works smoothly and with confidence; his joints are well made and fit truly. On the other hand, the workman whose knowledge of the

drawing is imperfect has, in a measure, to grope his way, he is uncertain of his results, and the work he produces is seldom without faults.

The construction of such a body as that of a landau should only be entrusted to, and can only be safely undertaken by, the most experienced workmen. Although accuracy is necessary in the building of all bodies, that of the landau demands the greatest skill and care, because the strains it encounters in use tend to alter its form much more than that of a carriage with a fixed top like a brougham. In such a landau as our example the standing pillars are worked out of 3¼-inch timber, in order that there may be sufficient room to receive the concealed hinges. The pillars are screwed to the rockers, and the elbows are lapped to the pillars at one end, and screwed from the inside to the bottom side at the other end of the elbow. Some bodymakers make a form of dovetail joint between the rocker and the pillar-foot, but this is of little or no advantage in stiffening them. The bottom sides are lapped on to the pillar and notched at the other end to take the elbow; they are also screwed to the rockers by, say, six screws.

The seat bars are lapped on to the rockers and tenoned into the pillars and screwed from the lock and hinge faces. The hind bars are tenoned into the bottom sides, and screwed from the bottom. The back and front bars are framed with a bare-shouldered tenon into the bottom sides, and screwed from underneath the elbow-rail, while the front boot bar is lapped to the bracket, which is screwed to the boot side.

The boot will generally have solid sides, which may be made from one inch birch. In our landau we have a "driving footboard" with the bracket at a good angle for effect; it is necessary to frame a bar across, between the brackets, to give a bearing for this footboard. We therefore frame the bracket to project a distance equal to the

thickness of the boot side, *i.e.*, one inch, so that when finished it is flush with the boot side panel. We test the boot by lining it from the pillar, to see that it lies correctly, and it should also drop slightly in front, in order to counteract the effect of the pressure when the weight is in. The framing is taken to pieces, and we proceed to box out the rockers, rebate, groove and bead, fit in the panels, let the hinges in, and frame the cross-bars.

When the quarters are framed and the rockers and boot sides are in place the smith may have one of the sides for fitting the edge-plates, the dimensions of which may be gathered from the tables already given. It has been explained before that the body-plate of a landau has to bear a very great strain, which tends to make the pillars settle inward and nip the door. This strain is greatest at the front pillar, and the plate must be thicker there than at any other part, and as it must be narrow at the boot it must of course be thickened at that point. The body-maker must take care to see that his plate is a dead fit, that the holes are kept clear of the corners and edges of the plate, which would otherwise be weakened, and that each bolt and screw fills its respective hole thoroughly. This is most important; careless drilling of the holes causes endless trouble and dissatisfaction. Some men prefer to have their edge-plates jagged, to give them a better grip of the wood, and it is no doubt a good plan. White lead should be used for the joints and in fixing the edge-plates, not only on account of its adhesive properties, but because it acts as a preservative on the surfaces of the wood and the iron.

One thing that must not be neglected at this stage is the weighting of the landau body before the doors are hung, in order to provide against the springing of the pillars referred to. The body being placed on trestles, back and front, should be loaded with weights equivalent to five ordinary men. We then strike the pillar tops with

a heavy framing hammer, and screw a tightly-stretched piece of strap iron across the doorway. This practically fixes the set of the body, and the doors can afterwards be hung.

While the body is in the hands of the smith the body-maker usually frames his doors. One or two battens are necessary in each to keep the panel in position, and holes must be bored in the bottoms to allow water to escape. There are few things so difficult in body-making as the proper fitting of landau doors. Some workmen prefer to make them catch at the bottom, and allow the lock to draw them up tight at the top to prevent rattle; but a landau door should always be kept up at the top, because the occupants of a landau, and particularly ladies, invariably lean on the top of the door when entering or leaving the carriage, and this, of course, eventually results in the door coming down. When the locks and dovetail catches are fitted, and the door is hung, the hinge pins ought to be in a perfectly straight line, otherwise the carriage will never be satisfactory. The top hinge, which may be one and three-eighths of an inch "concealed" pattern, should be as high as possible, and the bottom hinge as low as convenient.

For the bottom, an "outrigger" hinge is always preferable, but cannot be dispensed with if we intend to add folding steps to work with the door. Although it may be objected to on the score of not looking neat, it imparts steadiness and strength; and all practical men know that it is a very rare case in which self-acting steps do not ultimately strain the door.

In addition to the ordinary box lock, or the slam lock necessary for securing the door, we must, in the case of a landau, fit in lever locks, to prevent anyone opening the door while the glass is up, as, in that case, the frame would be strained and the glass broken. This lock is

fitted in the glass run of the shutting pillar of the door, and has a bolt which presses into a hole in the front pillar of the body, and prevents the door being opened until the glass is lowered, when the frame presses down the lever which stands out in the "run," withdraws the bolt and allows the door to be opened.

Many years ago Mr. Barlow, of Queen Street, London, considerably improved the lever lock by combining it in one piece with the ordinary spring-box. Instead of lever-locks some builders use safety flappers or glass-frame holders, which are made in the form of metal slides fixed to the door pillars, and folding down and lying flat on the rail when not in use. The act of pulling the glass-string, raises the slides against the pillars, and they hold the frames tightly in position, and allow the door to be opened or closed with the glass up, and without risk of breakage. If, however, they are not fitted with the greatest care, wind and rain will both get past them into the carriage, and they have, moreover, a tendency to rattle. Amongst other appliances invented for the same purpose was a "lever-lift," fitted to the fence rail and worked by the door handle. When the door was closed, and the glass up, the latter rested on a metal plate on the fence rail. Between this plate and the door handle there was a connecting rod, and when the handle was turned to open the door, the connecting rod raised the plate on the fence rail and the glass frame was lifted over and dropped into the door. Had it not been that the glass frame was sometimes broken and the bottom of the door knocked out by the force of the fall, the "lever lift" was a fairly satisfactory solution of the difficulty.

The ordinary lever lock sometimes becomes fixed, and needs careful treatment to get the door open or closed, but if fairly used it gives the best results.

In panelling the body we principally use mahogany, as

described in a previous chapter, strengthening the thin boards with canvas fixed with glue, to prevent them splitting or twisting, and we fix them in the grooves with white lead, securing them with pins where necessary, and blocking them round the inner edges to give additional strength, using a good linen canvas and freshly made glue that is thin and hot. For the bottom boards and seat boards we may use pine, and for the arch and under panels mahogany or whitewood, which we can obtain very wide, and is a very suitable timber. It is necessary to secure the bottom with two strap plates $1\frac{1}{4}$ inch wide, screwed and nailed on.

The next process undergone by the body is cleaning off. This merely means dressing off any inequalities in the surfaces, and bringing the lines of the body to a regular flowing sweep or curve Of course a well-built body requires very little correction of this kind.

We have now to build our folding head upon the finished body, and commence by cutting off the tops of the pillars in a perfect line with the door fence rail, the door rail having been made of a depth equivalent to the space occupied by the slats and the pillar top, when the head is down, so that the latter lies flat. Were it not to lie in a straight line, then there would be a possibility of it rising, with unpleasant consequences, when the carriage was in motion, and for this reason some landau heads which are not made to lie flat are kept down by straps. The truth of this cutting of the pillar tops should be very carefully tested, as the slightest deviation causes trouble.

The pillar hinges, of which there are a variety in daily use, are then fitted. Specially constructed pillar hinges were introduced in order that the head might fall back without the thickness of the folding pillar standing up above the hinge joint. Thus, with a pillar hinge we obtain a straight line along the top of the door rail and across the

top of the pillars. Grandy's or Mackenzie's hinges are widely used; both have their particular adherents, and both give satisfactory results.

The folding pillars are cut to length, and, together with the case rail, are rabbeted for the glass frames. The folding pillars and the case rail must be attached very accurately with the head mechanism, so that when the head is opened and folded back, the case rail is thrown out level with the pillar. The pillars must be perfectly square with the fence rail to permit the glass frames to slide freely. With a fine saw we cut the case rails on the bevel, and where they close we insert the thimble catches or cups and balls, to draw them into place when the head is up. The two centre hoopsticks are screwed to the case rails and the slats, which we curve on the outside, are screwed to the slat irons of the head joints.

It is customary to make the head droop from the centre to the back and the front, and to curve upwards on the hoopsticks, but it has been laid down as a rule that a landau head should not drop more than $1\frac{1}{4}$ inch from the centre to the end slats, and should not curve more than $1\frac{1}{2}$ or 2 inches on the top, while the top of the end slats should curve an inch beyond the extremities of the elbows, to prevent the head-leather falling in. In fitting the hoops to the slats we canvas the corners and test the head by cross-lining, so that it may be perfectly true and not require to be altered and re-adjusted when the head-leather has to be fitted.

During the last thirty-five years there have been many inventions for easily raising and lowering the folding heads of landaus. The names of Rock, Morgan, Fuller, Mackenzie, Hooper, Aldebert, Shanks, Burt, Scott, and others, are associated with inventions of great merit for this purpose.

Rock's invention was the forerunner of the many ex-

cellent and effective mechanisms we now possess. His plan was to use thin plates of spring steel, while Hooper's patent plan was to use spiral springs, working by extension instead of compression.

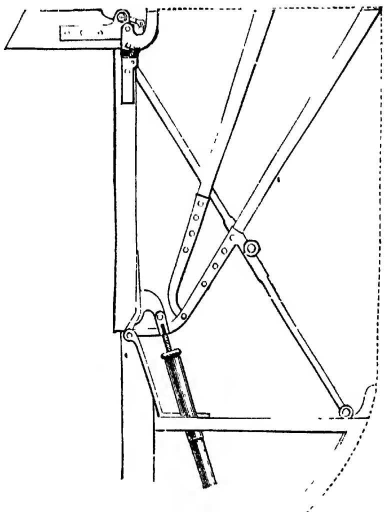


FIG. 39.—THE "CLIMAX."

More than twenty years ago Messrs. Harrison and Son, the well-known London coachmakers to the trade, invented a method of raising and lowering landau heads, which was a great improvement upon the existing methods. The inventors got their power from spiral springs in tubes placed below the elbow, the top end of the spring being

connected with the head by means of a rod. There used to be always a fear of the automatic head rising when the carriage was running, but the difficulty was overcome in this invention by the placing of the lower axis of the tube

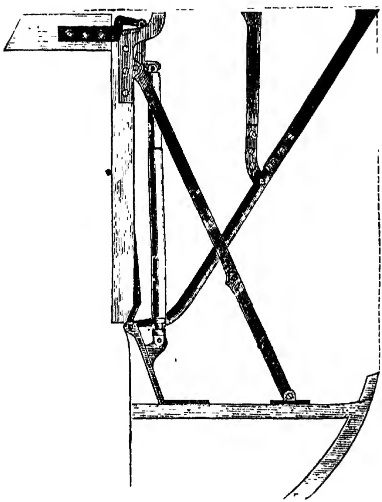


FIG. 40. THE "EUSTON."

so that, when down, the pressure of the spring was in a direction parallel to the "lie" of the pillar, and thus there was no lifting power exerted. If outside joints were used, then there was an arrangement by which the outside joint was struck by the movement of the cant-rail, but when coachmakers began to dispense with outside joints, the

inventors connected the cant-rail with the standing pillar or elbow-piece, and imparted the necessary motion by means of an eccentric rod.

Improvement in landau head mechanism since that period has been gradual, but it has been real. Coach-makers may now choose from several excellent inventions, which by their lightness and the accuracy of their construction have contributed a good deal to the present popularity of the landau. The mechanisms enumerated are inventions of members of the trade who knew what conditions had to be fulfilled by a good head lift, and who knew the faults of those that had gone before All depend more or less upon spiral springs for their power, the main difference being in the method of acting on the case rail. The principal object is to dispense with the outside joints, so that the head may be opened from the inside when the carriage is running if necessary. When some forms of outside joints are used, the carriage must be stopped, and the coachman or footman must get down to strike the joints.

As examples of two methods of dispensing with outside joints, without complicating the inside mechanism, we illustrate the "Climax" (fig. 39), and the "Euston" (fig. 40), head lifts. It will be noticed that in both cases the inside joints are connected with the case rail, and render it practically self-acting. The spiral springs in both cases are inclosed in tubes, but in the first example they reach below the elbow, and act upon the folding pillar, while in the second case they are above the elbow, and are attached to the case rail, causing it to shut down tight in its place when the head is closed.

In the "Universal" head lift, and in some other cases, the springs are not inclosed in tubes, because it has been found that noise, which annoyed the occupants of a carriage, and the cause of which could not for a time be discovered,

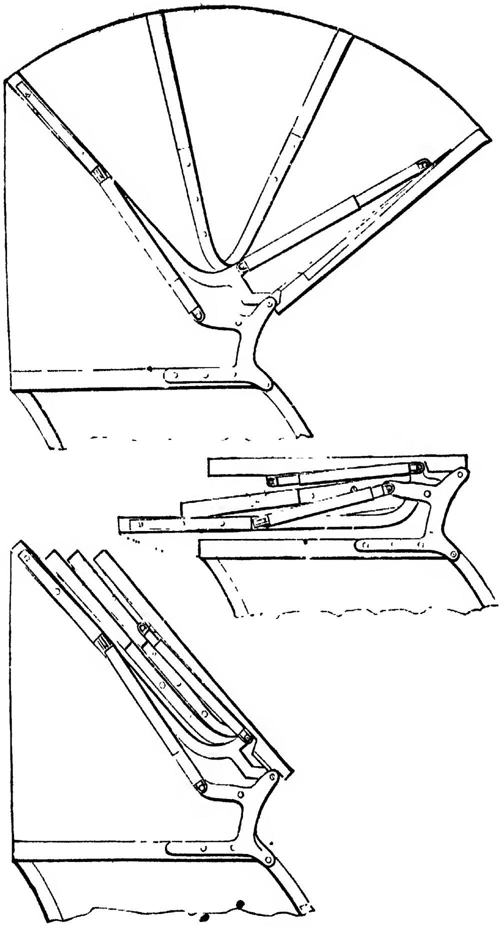


FIG. 41.—THE "DUPLEX."

[*To face page* 90.

arose from the rattling of the springs in the tubes when the carriage was running.

The fitting of a folding head to a phaeton, like fig. 1, is work that the young body-maker usually has to face after having passed his novitiate in building dog-carts and gigs, as a victoria body is generally his next step towards the higher branches of his calling. Our illustration shows a revival of the old cab phaeton, improved not only in outline and general appearance, but in space and comfort, and brought into use again by the patronage of a section of the wealthier classes. The head slats for such a carriage are obtained from the timber bender, who, in preparing them, requires to know the widths of the body at the pillars, where the head is hinged, and at the back; the length of the slats and the rise on the top from the back slat to the centre. Those measurements are obtained from the working drawing, and to ascertain that both sides are of precisely the same length, the slats ought to be laid flat, a straight-edge placed across the top, and a certain distance marked off on each side of the centre, from which points the lengths can be measured downwards. We are far from finality in the matter of folding head mechanism, either for landaus or phaetons, but in the "Duplex" head lift (fig. 41) we have a decided improvement.

With it we can also dispense with outside joints, and yet the leather is kept tight by the action of the springs on the inside irons, as indicated by the drawing. It also offers an advantage that will be appreciated by everyone who uses a victoria, as it allows the head to be securely locked in position when half way up.

In getting out the stuff for our brougham we shall require timber of the dimensions shown on the diagram (fig. 26).

Those are the pieces of the largest dimensions, the sizes being obtained from the working drawing, and judgment

used in allowing sufficient margin for dressing up to the finished sizes. The minor pieces of the framing, such as the cross-bars, rails, battens, and bottom boards also need care in the selection of suitable wood.

We need 2 front standing pillars; 2 hinge pillars; 4 door pillars; 2 cant rails; 2 rockers; 2 short bottom sides; 2 corner pillars; 2 boot sides (if solid), or boot bottom sides, contracting pieces and framing pieces (if framed); 1 boot bar; 1 boot rail; 2 back rails; 2 seat rails; 1 hind bar; 1 seat frame; 2 brackets; 4 door rails; 2 elbows; 2 door bottoms; 2 roof sticks; 6 battens; 2 bottom rails.

By taking the standing pillar and laying it on the drawing of the turn-under, we may mark upon it all the depths of the body, such as the distance of bottom sides to elbow, elbow to case rail, position of battens, etc.; and if the other pillars are marked from it, the chance of mistake is reduced to a minimum. The standing and front pillars are lapped on to the rockers and shouldered, and tenons are cut at the top to take mortices in the case-rail. In the case of a single brougham, we may join the front pillar to the case-rail with a tenon cut on the latter. The short bottom-sides are generally lapped and screwed on to the standing pillars, but sometimes they are tenoned into the back of it, the mortice being cut to correspond with the inside line of the bottom side. The bottom of the hind corner pillar is secured to the other end of the bottom side by a lap, or a lap and mitred joint, and the top of the corner pillar is lapped and screwed to the case-rail.

Half laps are cut in the standing pillar and in the corner pillar to receive the elbows, while the quarter battens are similarly lapped or notched into the corner and standing pillars. Having framed the sides of our body we round them in, or, in other words, dress them off true, so that

the whole of the side has a bearing on the sweep when it is tried on.

In cross-framing the body we tenon the hind bar into the short bottom sides, tenon the seat rail into the standing pillar—or half lap it if there is not room for the mortice and tenon—tenon our front cross rails into the pillar, lap the top back rail to the top of the corner pillars, and lap and screw the battens and back-light board from the outside.

Our brougham has a framed boot, and the parts must be framed to give the required outline and to have a drop or pitch downward of one-eighth of an inch or more in its length to counteract the tendency of the fore-carriage to raise it in front, and to prevent springing at the neck. The framing may be of 7-in. stuff, the boot bottom side being lapped on to the inside of the front pillar. The boot contracting piece should be thick enough to be flush inside and out when it is lapped to the boot bottom side. At the other extremity it is screwed to the front pillar, in which we box out a groove to afterwards receive the boot side panel, which ought to be well canvased. The framed boot side, however, is not so commonly made nowadays. Many builders prefer a solid boot side. This has to be bent inward at the bottom to the line of contraction, but it makes a strong job, as it will take the edge-plate bolts, which are covered by the panels, or it may be screwed if not panelled.

The framing is now boxed out, mouldings formed, grooves cut for panels, laps cut for battens, and hoop-sticks and the sides made ready for the edge-plates, and the concealed hinges let into the "standing" or hinge pillars.

We use two concealed hinges, one as high, and the other as low as convenient. The top hinge may be 5 in. or 6 in. below the case-rail, and the bottom hinge 5 in. below the elbow; but different makers have different ideas on this

subject, as we may find in some cases the top hinge 8 in. below the case-rail, and the bottom hinge $4\frac{1}{2}$ or 5 in. below the elbow. Some broughams with a good deal of turn-under may have two concealed hinges and an outrigger at the bottom, the top hinge being 5 or $5\frac{1}{2}$ in. below the case-rail, the middle hinge exactly above the elbow, and the outrigger at the bottom.

In special cases, where self-acting steps are used, or where there is a very pronounced turn-under, we may employ an outrigger hinge, but this is seldom necessary in the case of a brougham. In framing brougham doors we give the shutting pillar a little spring, causing it to touch at the top and bottom, and to be drawn up by the lock in the middle to prevent rattle.

With a brougham, more than any other carriage, we have to take precautions to prevent vibration and unpleasant sounds when the carriage is in motion. In some broughams the noise is so great as to be an intolerable nuisance, and generally the cause is very difficult to discover. It often happens that the fault lies in badly made springs or improperly fitted bolts in the under-carriage, but it will be readily understood that if the framing of the body is not rigid it will spring when the weight is in it, and cause a creaking noise. Panels may vibrate, boards or rails may be catching them, glass-frames may rattle, and other things may cause unpleasant noises in the body of a close carriage, so that it is necessary that every joint should be truly fitted and tightly screwed. It has been observed that a brougham with a good curve on the roof is less liable to sound than one with a flatter top, and we therefore give our hoop-sticks a moderately good upward sweep, say 2 in., and notch them into the cant-rail. We feather and groove our roof boards, give them a fair bearing upon the hoop-sticks and the front and hind rails, and nail them down.

The advantage of getting out the panels at the same

time as the framing has been referred to. They should always be fixed with white lead in preference to glue, because damp has less effect upon the lead.

We presume that our brougham is one of the best quality, and that being so, the roof, back, and quarters of the body will have to be covered by the trimmers with a wet hide of russet leather. The panels are united with a mitre joint and carefully pinned down, and the filling of the holes over the pin-heads, though not the body-maker's work, must be very carefully done, or the filling will show under the hide after the carriage is finished, and it is then impossible to remedy the fault. The careful body-maker planes up his panels on both sides, and sees that in the quarters the grain of the panel board runs up and down. The slovenly workman dresses one side only of the panel, and says that the unplaned surface holds the glue better.

When the panels are fixed they are blocked round the edges and where the battens cross, and the roof is carefully blocked, as much to prevent vibration as to impart strength. The bottom boards are put in, the strap plates put on, the boot seat framed and the heel board made, the whole cleaned off, and our brougham body is ready for the carriage-maker to hang-on.

It has been mentioned that the construction of a landau and a brougham body may be said to embody the cardinal features of the framing of all other carriages, and on that account they have been adopted as examples in this book. Practices, however, differ in various parts of the kingdom, and there are many things in carriage body-making in which the observant workman may profitably discard old ways and methods, and by exercising his mechanical ability and scientific knowledge save time and material, make his labour easier, and his productions better. Nowadays there is no reason, in large towns at any rate, why the

apprentice should pick up his trade in the precarious manner which was common in former years. Sound scientific knowledge may now be acquired in the technical and science classes which have been established in almost every town, and it is to the interest of everyone engaged, not only in carriage building, but in any other trade, to fit himself to produce work as economically and as well as our competitors.

CHAPTER VII.

CARRIAGE-MAKING

The "carriage-maker's" tools.—The component parts of a perch and C-spring-carriage.—Parts of an ordinary wood-and-iron fore-carriage.—A close futchell fore carriage.—Wooden futchells.—Compassed beds.—Proportional measurements of wheels, axles, and axle-boxes.—Carriage tracks.—Setting out the under-carriage.—Position of the transom.—Dimensions of shafts.—Standard sizes.—Plating the fore carriage.—Fixing the springs.—Hanging and balancing two-wheeled carriages.—Shafts on the fulcrum principle.—Shifting seats.—Sliding bodies.

WHEN Felton wrote his "Treatise on Carriages" in 1796, the art of the "carriage-maker," *i.e.*, the construction of the underworks of a carriage, was equal in importance to the building of the body, but the invention of Elliott's elliptic spring marked the beginning of a decadence in "carriage-making" that is still continuing, and it may be safely asserted that before many years have elapsed we shall seldom see a C-spring perch carriage, except on State occasions. Good "carriage-makers" with real mechanical skill are becoming more scarce every year, because there is much less work required in the under-carriage of an elliptic-spring vehicle than in one with a perch and C springs, and it is now very usual to find the work of both "body" and "carriage-maker" done by one man.

There is no part of a carriage that deserves greater care and attention in its construction than the underworks. The "carriage-maker" should not only be a good mechanic, but he should be able to carve respectably, and should have an eye to proportion; for an ill-proportioned fore-

carriage will ruin the appearance of the best body that was ever made.

The special tools used by the "carriage-maker," in addition to those which are common both to him and the "body-maker" (*see* figs. 27, 27*a* and 27*b*) are:

68. Auger.
69. Set of carving tools.
70. Iron spokeshave.
71. Bolt cutters or clippers.
72. Bolt clam.
73. Downie block key.
74. Clip wrench.
75. Box wrench.
76. Perch bolt wrench.
77. Bolt breakers (disused since the introduction of bolt clippers).
78. Clip wrench.
79. Drift bolts or pins.
80. Cotter punch.
81. Screw plate.
82. Bolt turner.
83. Callipers
84. Adjustable screw wrench.
85. "Carriage-makers'" beading tools.

Fig. 42 shows a perch under-carriage, which, with a few exceptions, could scarcely be more correctly described today than it was by Felton.

The component parts of this under-carriage are:

The forged iron perch.	Felloe piece.
Iron wing stay.	Sway-bar.
Front transom.	Splinter-bar.
Hind transom.	Futchells.
Horn-bar.	Pole.
Nunters or framing pieces.	Wheel plate.
Front axle-bed.	Spring stays.
Hind axle-bed.	Wheel irons.

Of the wooden parts of some under-carriages the perch, sway-bar, and horn-bar are plated with iron.

Felton said: "The perch, which is the main timber of the carriage, extends through the hind and fore spring transoms or bars. The hind bars are supported and united

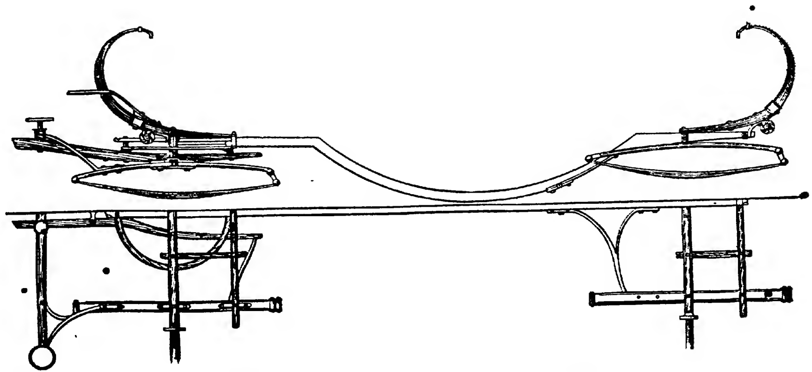


FIG. 42.—PERCH AND C-SPRING UNDER-CARRIAGE.

to it by means of hooping two extending timbers, called wings, on each side. The fore end is fixed or united to the

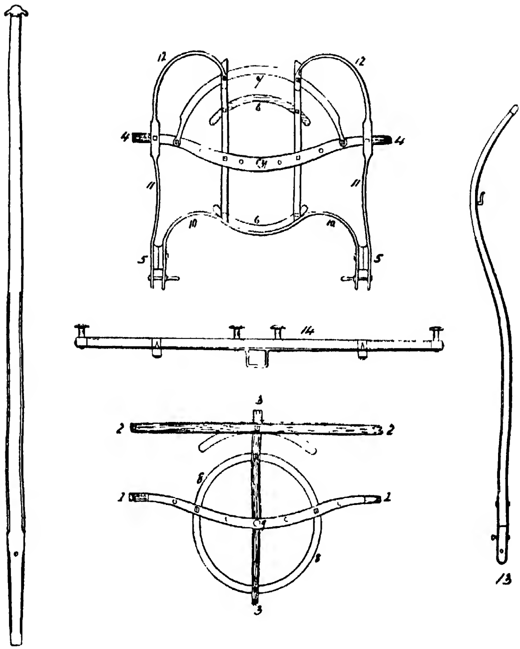


FIG. 43.—FORE-CARRIAGE WITH OPEN FUTCHELLS.

perch by means of a strong piece hooped at the top and framed through the fore transom, called a hooping piece, with a horizontal wheel plate in the front; but some have

no hooping piece to the perch, but are secured by means of flaps from the iron side plates." The "dumb irons," or dumb springs, are made of iron, and carry the axle-bed, and were formerly covered with wood, carved or beaded to harmonize with the other parts of the under-carriage.

In 1841 Messrs. Hooper, the London coachmakers, introduced the iron or steel perch, and in doing so they obtained three advantages: the body could be hung lower, the weight could be reduced, and smaller and faster horses could be used for longer distances. At the same time a chariot was built for the late Lord Sudeley with a double perch, by which they gained a full lock for the fore-carriage and prevented side bending. We have, however, pointed out that this style of under-carriage finds very little favour nowadays, chiefly on account of the weight it entails and the increased horse-power necessary to draw the vehicle. Moreover, the iron or steel perch is very liable to be strained when the front wheels encounter obstacles on the road; and the action of the springs when the carriage is loaded and running is such as always to cause the perch to bend or spring in the middle, so that in making it, it is necessary to give it a "set" in the opposite direction to counteract that tendency.

Fig. 43 is an ordinary wood and iron fore-carriage, the component parts being:

1. Top bed, or transom.
2. Horn-bar.
3. Framing piece, or tongue piece.
4. Bottom, or axle-bed.
5. Futchells.
6. Felloe pieces.
7. Sway-bar, or sweep piece.
8. Wheel plate.
9. Perch-bolt.
10. Front stay.
11. Wheel iron.
12. Hind stay.
13. Shaft.
14. Movable splinter-bar and pole are used for a pair of horses.

The next illustration (fig. 44) is a fore-carriage with close futchells and fixed splinter-bar, for use with a pair of horses. These two fore-carriages may be regarded as standard types, although there is an endless variety in use at the present time. Many are entirely of iron, and look

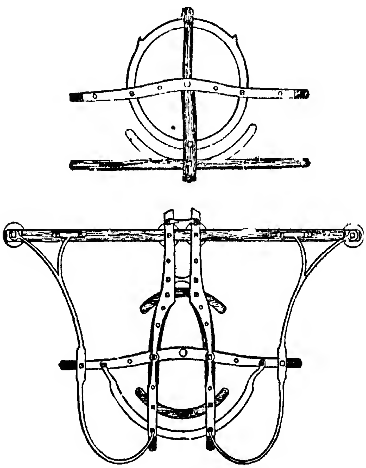


FIG. 44 —FORE-CARRIAGE WITH CLOSE FUTCHELLS.

decidedly lighter, but they vibrate and rattle, are easily bent, and, when bent, difficult to set fair again. The combination of wood and iron is found to give the best results in the way of strength; but individual builders have their own ideas as to form and strength. Some fore-carriages are made with the wheel iron terminating at the spring, but it is better to carry it round at the back to support the

futchells. We sometimes observe pair-horse fore-carriages with two framing-pieces instead of futchells, some with the perch-bolt set in front, while one carriage may have a sway-bar and another has none.

There is one change in under-carriage framing in which coachmakers have been practically unanimous during the last fifteen or twenty years, *i.e.*, the disuse of wooden futchells in single-horse fore-carriages. The present form of construction is stronger, lighter, and more durable; because wooden futchells, having been steamed and bent, and having to endure intense vibration, generally rotted, and eventually gave way under the strain they had to bear in work.

Except in special cases, the axle-bed is compassed, *i.e.*, it is curved forward at the middle, where the perch-bolt passes through some two or three inches, beyond a straight line connecting the ends; or, in other words, the perch-bolt is two or three inches in front of the axle. This is equivalent to shortening the coupling of the carriage by that distance, for the wheels, turning round the perch-bolt as a centre, describe a line so much further in front of the arch panel, and risk of injuring it is thus prevented; but this compassing of the bed must be kept within reasonable limits, or the carriage is liable to be upset in turning, because the fore-carriage is then so much further from under the body, and, if there happen to be greater weight at that side than at the other the danger is increased.

In the larger manufactories, where the working drawings of carriages are made in detail, as indicated in the first chapter of this book, the "carriage-maker" is not entrusted with the work of proportioning the under-carriage, fixing the position of the fore-carriage, the height of the wheels, length of axle, length and compass of springs, etc., because his employer or foreman has set out the dimensions on the drawing. In smaller establishments, however, this is too

frequently left to the discretion of the workman, and the result is consequently often unsatisfactory to himself, to his employer, and to the buyer.

In the table of proportional measurements given in the first chapter, the "carriage-maker" will find the heights of wheels, lengths of axles, and lengths of springs, which are more or less customary in good work. That information, together with the table on the opposite page, will, if carefully studied, tend to save the workman much trouble and thought in the absence of a reliable working drawing.

In the matter of axles this table goes further than Mr. Terry's, inasmuch as it contains the average weight on each axle when the carriage is loaded, the size of the flap, length of axle, the track of the wheels, and other dimensions which the "carriage-maker" should know. In setting out the "carriage-maker's" work there are really not many calculations necessary, and they are not difficult, so that little excuse exists for errors With ordinary care in apportioning the heights of the beds there is no necessity for those ugly, deep spring blocks which spoil the look of so many carriages. Given the height of the body from the ground, the "carriage-maker," with the aid of a straight-edge laid along the elbow, takes the difference in the height of the front end and the hind end, where the pump-handles are fixed, and he can then readily mark in the heights of his wheels, the depths of spring blocks, compass and thickness of springs, and the depths of the beds. Sufficient locking room must be assured, and if any doubt exist this may be tested by making a drawing like that of the landau fore-carriage, fig. 23.

Some years ago, in delivering a lecture on the principles to be observed in designing carriages, Mr. G. N. Hooper laid down a very simple and useful rule for finding the position of the transom, his example being an angular landau :

AVERAGE HEIGHTS OF WHEELS AND DIMENSIONS OF AXLES.

Reprinted from Mr. Wm. Philipson's Essay on "Suspension."

Name of Carriage	Height of wheels.		Weight loaded		Size and kind of axle	Size of flaps.	Length of axle-box	Distance.			Carriage track (centres).
	Front.	Hind	Front.	Hind.				Between flaps.	Outside of flaps to back of naves	Back of naves	
	ft. in	ft in	cwt	cwt	in	inches	inches	inches	inches	inches	ft. in.
Brougham, large	3 2	3 10	11.73	10.02	1¼ Collinge	1½	8½	36	3¼	45½	4 6
Do. small	3 1	3 8	9.89	8.11	1½ ,,	1½	8	34	3¼	43½	4 3
Do. single	3 1	3 8	8.18	7.57	1½ ,,	1½	8	34	3¼	43½	4 3
Landau, large	3 3	4 0	10.99	9.00	1¼ ,,	1½	8½	36	3¼	45½	4 6
Do. small	3 0	3 9	10.02	7.97	1½ ,,	1½	8	34	3¼	43½	4 3
Victoria Phaeton	2 11	3 8	9.22	7.78	1½ ,,	1½	8	34	3¼	43½	4 3
Stanhope Phaeton	3 4	4 0	4.26	8.49	1½ ,,	1½	8	34	3¼	43½	4 3
Back-to-Back Phaeton	3 4	4 0	5.43	7.07	1½ ,,	1½	8	34	3¼	43½	4 3
Park Phaeton	2 8	3 8	4.49	9.20	1½ ,,	1½	8	34	3¼	43½	4 3
Pony Phaeton	2 2	2 10	2.68	7.32	1 Mail.	1½	7	34	2	41	4 0
Whitechapel, large	4 10	..	11		1⅜ ,,	1¾	8½	35½	3¼	45½	4 6
Do. medium	4 8	.	9	.	1¼ ,,	1½	8	35	2¼	43½	4 3
Do. small	3 8	...	8		1 ,,	1½	7	34	2	41	4 0
Stanhope Gig	4 7	..	7		1¼ Collinge.	1½	8½	35	3¼	45½	4 6

Half of the distance over the top of front wheels ... . say	31	inches.
Deduct compass of beds . .. "	$3\frac{1}{2}$	"
	$27\frac{1}{2}$	"
Add sufficient space for the wheels to clear body in turning say	4	"
	$31\frac{1}{2}$	"

Making $31\frac{1}{2}$ inches as the distance of the transom from the back of the arch-panel at the seat line.

If the fore-carriage is one with wooden futchells morticed through the beds, the thickness of the futchells should be $1\frac{1}{2}$ in. for a pair-horse carriage, $1\frac{3}{8}$ in. for a single-horse carriage, and $1\frac{1}{4}$ in. for a pony-carriage, with a width inside the futchells at the shafts of 2 ft. 10 in., 2 ft. $8\frac{1}{2}$ in., and 2 ft. 6 in., respectively. The length of the pole for a pair of full-sized horses is 9 ft. 2 in. from the splinter-bar to the pole end, while the splinter-bar should be 5 ft. 4 in. long, and proportionately shorter for smaller animals. The shafts of a four-wheeled carriage for a 16-hands horse may measure 4 ft. 8 in. from the bolt to the centre tug, but in vehicles where the fore-carriage is kept well under the boot, as in a landau, the shafts should be some inches longer, to prevent the horse coming in contact with the dasher or footboard in turning.

In 1880, someone writing over the initials A. K. published in the "Saddlers', Harness Makers', and Carriage-builders' Gazette" the following table of standard sizes for shafts. Some people may object to certain measurements as being too large or too small, but the list may be accepted as the production of one with a practical knowledge of his subject.

	16 hands.		15 hands.		14 hands.		13 hands.		12 hands.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
Width between shafts at the back band tugs . .	2	0	1	10	1	8	1	6	1	4
Height from ground under shafts at tugs ..	4	4	4	1	3	10	3	7	3	4
Length from the back tug to shaft tip ..	1	10	1	8½	1	7	1	5½	1	4
Width inside shafts at futchells	2	10	2	8	2	6	2	4	2	2
Length from back tug stop to trace bolt . . .	4	4	4	1	3	10	3	7	3	4
Length of hind end of shaft from step bar to back bar or swinging coupling .	4	6	3	11	3	8	3	5	3	2
Total length of shaft from draft bar to tip	6	4	5	11½	5	7	5	2½	4	10
General height of draft bar from ground ...	2	10	2	8	2	6	2	4	2	2
Distance of breeching staple from trace draft bolt	2	5	2	3½	2	2	2	0½	1	11
Distance of kicking staple from trace bolt . ..	1	1	1	0	0	11½	0	11	0	19

Some dimensions recommended by the Institute of British Carriage Manufacturers for horses of the same heights are:

	16 hands		15 hands		14 hands		13 hands		12 hands.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
Width between shafts at the back band tugs	2	2	2	1	2	0	1	11	1	10
Height from ground under shafts at tugs	4	4	4	1	3	10	3	7	3	4
Length from dasher to tug stops	4	9	4	6	4	3	4	0	3	0

The ash used by the "carriage-maker" should be the toughest that money will buy, and is cut out by band and frame saws to the required patterns. The "carriage-maker," like the "body-maker," faces one side of his

timber, and should gauge everything from the faced side. His mortices must be cut small, in order that his framing may be tight, particularly when wooden futchells are framed through the bed. In the middle of the bed, thickness and strength should never be sacrificed to lightness, owing to the manner in which the wood is cut away for the perch-bolt hole, and it is a general practice to make the bed twice as wide as the diameter of the perch-bolt.

Badly ironed fore-carriages are very common, and the twisting wrench is sometimes resorted to, to remedy defects. This has led to the suggestion that the wood should be fitted to the ironwork; but this would not prevent faulty work on one side or the other. It would appear needless to point out that sound, well-fitting work in the ironing of a fore-carriage is imperative, and that the wheel plate should be a true circle with a perfectly flat bearing; it should impart steadiness to the whole structure. Each plate, when finished, should fall into its place and bear on the wood without forcing, and a sufficient coating of chalk should be used to prevent the timber being charred by the hot iron in fitting. Those points being carefully observed, the "carriage-maker" will take some degree of pleasure in dressing up his beds, beading and carving his carriage, and displaying that measure of taste for which there is always an opportunity. As to the fitting of the springs before the body is turned over, Mr. G. F. Budd, in his admirable prize essay on the "Underworks of Carriages," says: "The front elliptic springs in all descriptions of carriages should in no case be wider apart than $\frac{1}{2}$ in. less than the outside width across the body immediately above the axle; for instance, should the body be $33\frac{1}{2}$ in. across at that part the springs should not be more than 33 in., so that the body will have at least $\frac{1}{4}$ in. direct bearing above the spring in a vertical direction, which will have the effect of throwing considerably less strain upon the under-carriage."

In the chapter on "Suspension" we have dealt with such questions as the inclination and methods of fixing springs, the application of brakes, methods of testing a carriage, etc., so that we may now devote a little space to the subject of the underworks of two-wheeled vehicles.

The variation in the size and shape of two-wheeled carriages very often gives rise to some difficulty in balancing the body for a varying number of passengers. There is no hard and fast rule for calculating the position of the axle of a two-wheeled carriage. The fact is, the body of a two-wheeler should not balance perfectly when empty, but the front should have a little more weight than the back when level, because it is necessary to put a moderate weight on the horse's back to steady him, otherwise, when the cart was fully loaded, it would pitch backward, and tend to lift the horse off his feet. This plan of leaving weight forward sometimes places the manufacturer in an awkward position when trying to sell a cart. His customer may lift the shafts, and finding a little weight forward declines to purchase the carriage, because he thinks it will be heavy on the horse's back, entirely forgetting that the balance may be perfect when it is loaded. The simplest and best way of adjusting the balance of a two-wheeled vehicle is to have shifting or sliding seats, and to make and attach the shafts on what is commonly termed the fulcrum principle, the fulcrum being either at the bar or further along the side of the body. The cardinal principle of hanging shafts on fulcrums, now universally adopted, was invented and patented by Messrs. G. and T. Fuller, of Bath, *circa* 1825.

The hind ends of the shafts are secured in a variety of ways, some having shackles lined with rubber, some being held between rubber bobbins, and others having a light cross spring between them to give a compensating motion. The shaft should play throughout its length, that part behind the

bar being dressed down and carefully tapered toward the back end, which, if the method of attachment permit, may have a neatly carved end. The iron stays, or strolls, by which the ends of the shafts are connected to the body, should always be bolted to the body framing. If they are merely screwed, the leverage, or play of the shafts, soon breaks them away from their fastenings. The splintree, or draw-bar, may be of iron clipped on to the shafts, or of wood framed into them; but, unless the body be specially made, there should always be a bar, for not only does it make a stronger and safer finish, but it does away with much of the noise and rattle noticeable in cheap, inferior work where there is no bar. Of course, it cannot be denied that there is a certain advantage in having one shaft to play independently of the other.

The balance of a dog-cart body may be perfectly adjusted for varying loads by making it to slide on rods bolted on the shafts, the power being got by means of a lever handle fitting into a rack, in the same way as a brake at the driver's side of the body, or by means of a screw worked by a handle. In order that the shafts may be kept perfectly parallel, they must be connected at the back by a hind bar, which is often made of iron for lightness. A second method is to frame the shafts with a wood bar at the back, and to have two parallel tubular rods running from the draw-bar to the bar at the back, and bedded into them, the body having gun-metal slides running on the rod. Sliding arrangements generally have their little defects, and unless the parts are carefully made, and kept in good order, the connections become noisy, and it sometimes occurs that the body cannot be moved when fully loaded, and just at the moment when the horse is about to ascend or descend a hill. When shafts are framed with a bar at the back, they are not dressed down, but left almost square, and being fitted with plates

they do not work so easily as shafts hung on the fulcrum principle.

As to the position of the axle in two-wheeled carriages. In the case of a gig, or other vehicle for two persons, it is usually taken at a point understood to represent the middle of the body, with just a little weight thrown forward on the shafts This point may be 1 inch behind the front edge of the seat, or it may be from 4 to 6 inches, according to the shape of the body If there be any doubt as to what is the real centre of a body, it can be removed very speedily by a simple test. The body may be placed upon a small wooden roller resting on the floor, and then evenly loaded with the necessary number of sitters, and moved on the roller until the equipoise is found and the point marked on the body. This may appear primitive, but it is nevertheless effective With a cart having shifting seats for four passengers it is a safe rule to take the axle centre in a vertical line with the back of the front seat, which will be 10 to 14 inches wide. In "Governess" cars, or "tubs," the best rule is to square the body and take the centre.

CHAPTER VIII.

WHEEL-MAKING.

Wheel-maker's tools.—American wheels. Dished wheels.—Cutting and dressing spokes.—Machine-made spokes. Automatic spoke lathe.—Spoke-tenoning and throating-machine.—Morticing naves.—Nave-boring and morticing-machine.—Hand-power machine. Forming the rim-tenons on spokes.—Oval tenon making machine.—Tenoning- and felloe-boring machine. Dressing the felloe by hand.—Joint-way.—Bent rims.—Rim-bending machine.—Felloe-planing machine.—Rim-dressing machine.—Wheel-tread sander. Boxing.—Hub-boring and boxing-machine.—Changes in wheel construction.

IN the department of wheel-making the use of machine tools—"hand" and "power"—has spread more than in any other branch of coachmaking. It is more than fifty years since some provincial coachmakers commenced to apply machinery, but its use has not increased to the same extent as in other trades which might be mentioned. There are several reasons for this, which we need not stop to discuss here, but it is certain that the ready and intelligent adoption of well designed and efficient labour-saving machine tools has been the greatest factor in the success with which the wheel-makers of the United States and Canada have invaded the United Kingdom with their productions.

A difficulty that has always stood in the way of a general adoption of machinery is the impossibility of finding employment for a full equipment of wheel-making tools in a single carriage factory; for machinery is not profitable unless it is worked up to its capacity. An automatic spoke

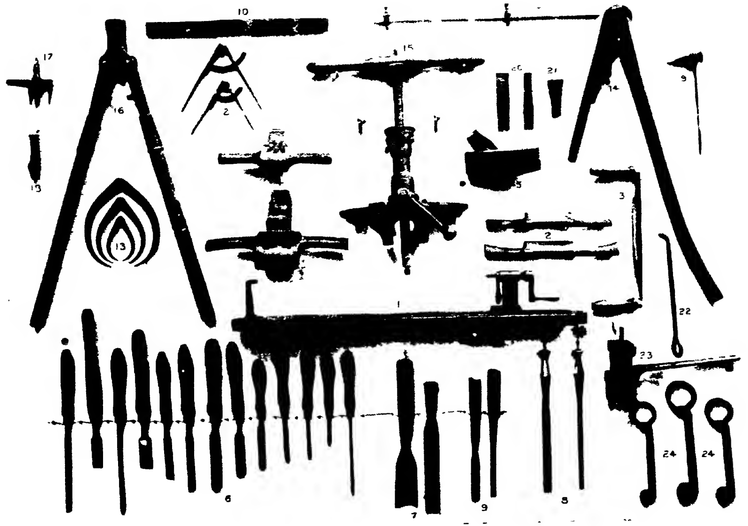


FIG. 45.—WHEELER'S TOOLS.

[To face page 112.

lathe will turn 2,700 one and a quarter inch spokes in ten hours, while as many as 10,000 spokes have been tenoned in the same time by a machine specially constructed for the purpose. These figures make it plain that such machines could only be worked to a very small fraction of their capacity by the ordinary coachmaker, even if he possessed the necessary motive power. Their employment has therefore been left to large companies, who make nothing but wheels, and who can find an outlet for their immense productions. It is difficult to understand why so many American made wheels are used in this country. They are usually well and accurately built, but why should our wheel manufacturers not use similar machinery and produce similar work? Our timber is neither so cheap nor so plentiful as American "lumber," but in quality it is quite as good, and there are numerous machine manufacturers in our large centres who build wheel-making machines capable of turning out work of the best class, and in the largest quantities.

There are, however, several machine tools, both "hand" and "power," which the coachmaker does use in this branch of his business, and with the best results. So changed are the conditions to-day that it would be hard to find a wheeler who remembers the time when the workman went and felled his own timber, cut his spokes to the necessary length, and split them with wedges and placed them in a stream of water for two or three months, after which they were dried in the open air. The work of the wheeler used to be very laborious. He had to turn his oak stock in a hand lathe, cut his felloes to the sweep with a saw, and dress his spoke with one end of it pressing against his chest.

The hand tools usually employed by a wheeler in carriage factories where he has the use of such power machines as circular saws, lathe, boxing machine, spindle for rim dressing, etc., are shown by fig. 45. This list does not, of

course, include such tools as saws, planes, etc., which are *common to all* wood-workers in a carriage factory, and which have been illustrated in previous chapters.

1. Spoke-holder for dressing.
2. Spokeshaves.
3. Draw-knife.
4. Wheeler's jarvis.
5. Compass felloe plane.
6. Turning tools for naves.
7. Boxing gouges.
8. Mortising buzz.
9. Mortising chisel and gouge.
10. Dowel plate.
11. Spoke gauge.
12. Dividers.
13. Callipers.
14. Rim gauge.
15. Hub-boxing machine.
16. Bolt cutter.
17. Washer cutter.
18. Collar washer punch.
19. Rivet punch.
20. Boxing wedge chisels.
21. Wedge punch.
22. Box cleaner.
23. Adjustable cap wrench.
24. Ordinary cap wrenches.

Wheels are now made with less "dish" than was formerly the practice, and they look all the better for being more upright; but in wooden wheels we cannot dispense with "dish" altogether; and the fact that the "dished" wheel has been used for so many years proves that it possesses advantages which outweigh the increase of friction that its use entails. Its advantages are:—(1) that the wheel is stronger, cannot go "back-over," and resists side-thrusts better than the upright form; (2) that the wheel tends to run up the arm, causing the axle-box to bear against the collar, instead of the wheel running down the arm and causing the box to press against the collet and nuts; (3) that the body of a carriage may be made wider without increasing the length of the axle; (4) that mud is partially thrown away from the carriage when the roads are dirty.

In former times the felloes were bound together by straps of iron called a "strake" tyre, but for many years a *whole*

tyre, made of a single bar moulded into a hoop, has been used. Dish enables us to get a tension on such a tyre, and causes the wheel to remain tight longer than one of upright form; for, as the wood shrinks—as it will shrink, however thoroughly it may be seasoned, or however well the wheel may be made—the spokes become more upright, and keep the tyre tight.

It is a general custom now for the coachmaker to keep a quantity of ready-made American spokes of various sizes, but some of the larger establishments keep stocks of home-

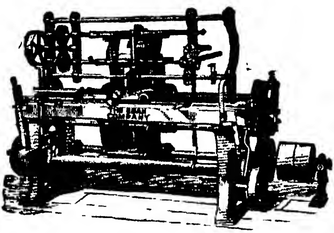


FIG. 46.—AUTOMATIC SPOKE LATHE.

grown oak spokewood in the rough. In such factories the wheeler cuts his wood to the necessary sizes at the circular saw bench, using two small saws with a tenon gauge between them for cutting the tenon. He then dresses the spoke to shape with draw-knife, plane, jarvis, and spoke-shave, finishing off with sandpaper. When dressing spokes in this fashion the wheeler should always use a spoke-holder fixed to his bench, both for his own comfort and the greater speed with which the work can be done. As a contrast to this method we will see how spokes and other parts of a wheel are produced by modern machinery.

By the courtesy of the J. A. Fay and Egan Company, of Cincinnati, who make a speciality of wheel-making

machinery, the most recently built tools of their construction are illustrated, with a view of showing to what state of perfection this branch of our trade has been brought.

Spokes should always be cleft instead of being sawn, but whether cleft or sawn they are cut to the exact length, and one is placed between the centres of the machine below the pattern. The movement of a lever lifts the vibrating frame, and brings the spoke to the cutter-head, which revolves at a high speed. The carriage travels along the ways, cutting the barrel of the spoke, and when the cutter reaches the large head of the spoke the speed is changed automatically. The head of the spoke is cut square, and when the cutting is completed the vibrating frame is thrown forward automatically to the operator, who has another rough spoke ready to place between the centres before the carriage returns to its position. From the lathe the spokes are carried to a spoke-tenoning and throating machine.

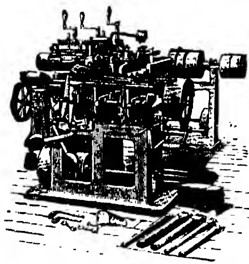


FIG. 47.- SPOKE-TENONING AND THROATING MACHINE.

In working this machine the attendant takes up the spokes from the truck that brings them from the lathe, and places them, one after the other, on the travelling bed. The head of the spoke passes between heads which cut the tenon, and also the throat of the spoke on both sides, so that when it leaves the machine it is ready for sandpapering.

The mortising of a nave by hand is the most important work that the wheeler has to perform, for a little carelessness or error in the angle of the mortises causes a faulty

wheel. The spokes of hand-made wheels are usually mortised with slightly more dish than is required, to prevent any inclination of the wheel to go *back-over*. In order to prove that the buzz is cutting at the correct angle, a straight-edge should be frequently tried over the end of the hub to test the distance of the spoke ends from it. If the spokes are mortised without sufficient dish they will have to be pulled forward, which may result in breaking the front of the mortises in the nave. The fit of the spoke endways in the mortise must, of course, be tight, $\frac{1}{16}$ in. being an ordinary allowance.

The nave-boring and mortising machine may be either hand-power or like the Fay-Egan tool (fig. 48); but in either case its work is much more accurate than can be produced by hand labour. In the above machine the holes are first bored round the stock, these being an index plate, by means of which the work is spaced. The workman presses a treadle with his foot, and the chisel comes down to the full stroke, there being stops on the bed to gauge the depth of the mortise, the width being gauged by the chisel itself. To obtain the necessary dish the nave is canted by means of a lever on the front of the machine.

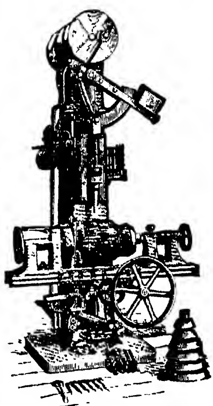


FIG. 48.—HUB-BORING AND MORTISING MACHINE.

Messrs. Joseph Green and Nephew, of Leeds, have for some years made a very perfect machine for boring and mortising naves. It has a division plate for spacing, an excellent raising and lowering arrangement for providing

the dish, and, by means of the patent mortising chisel that is used, the chips are withdrawn from the mortise at the return stroke.

The spokes of all ordinary carriage wheels should be driven by hand, the nave being held on the top of a wheel-pit, where it is under the control of the workman. In the United States spokes are driven by a hammer-head attached to a steel spring handle or shaft. In some wheel factories a spoke-driving machine is used for heavy work, such as hansom cab, and wagon wheels, the machine being capable of giving a very light tap or a very heavy blow, and having a device for regulating the dish.

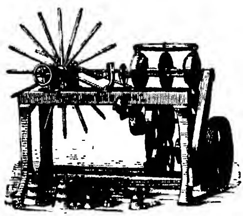


FIG. 49.—OVAL TENONING MACHINE.

Cutting tenons on the spoke by hand with a draw-knife very seldom gives a good fit in the rim, and, consequently, wedging the spoke-end is always necessary: but in well made machine-built wheels we often see wedging dispensed with. If the timber is thoroughly dry the tenons fit closely, and they are much stronger when they are not split by a wedge. In the absence of machinery the wheeler should use an adjustable hollow auger for cutting his rim tenons.

Oval tenons are now being made by some firms instead of the round shape, which, it is argued, weakens the rim sideways by taking away too much wood. The long side of the oval tenon runs lengthwise of the rim, and there is not so much liability to split the latter.

Fig. 49 shows the Fay-Egan machine for producing oval tenons. The workman places the wheel between the two cups, and with his left hand brings down one spoke, which

is clamped in two circular jaws operated by the man's foot. With his right hand he lifts the cutter-head and cut-off saw to the work, one revolution of the cutter completing the work.

There are several hand machines for tanging and felloe-boring used in this country. They cut the tenons of uniform diameter, and the shoulders are all at the same distance from the centre of the wheel. They generally have a table, on which the felloe may be cramped, and which may be raised or lowered to suit the different sizes of felloes, the hole for the tenon being bored by a suitable bit, instead of the tanging chuck used for the spokes. In hand-made wheels the rough felloe is faced and cut to the required thickness by the circular saw, and bellied out in the felloe-block with an adze. The proper bevel of the ends having

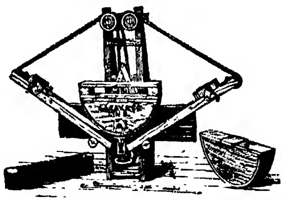


FIG. 50.—WOOD-BENDING MACHINE.

been found by carrying a straight line from the centre of the nave to the rim, the joint-way is cut at the saw, an opening being left at each side of the line, so that when the felloes are driven the joint is tight on the inside, and open from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. on the outside. This is most important, as the rim is like an arch, and when the tyre is put on this joint-way is drawn up and closed, and the wheel firmly bound. A wheel with a periphery formed by two bent rims is usually more difficult to repair than one with six or eight felloes, because, when a fault appears, a single felloe may be taken out and replaced much more readily than a rim forming half of the wheel's circumference. Bent rims, however, have much to recommend

them over ordinary felloes, as they make a neater and a more durable wheel.

In their preparation a wood-bending machine like fig. 50 is employed. The timber is softened in the steam-box, and then placed on the table of the bender, when the movement of a lever forces the rim round a block of the desired radius, and holds it in position until a strap or bridle is placed on it, when the rim is removed and set away to dry. If the rims are small, a number may be bent at one time.

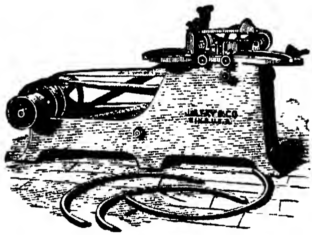


FIG. 51.—FELLOE PLANER.

The workman takes a dry and seasoned rim and places one end in the feed-rolls of the planing machine (fig. 51), which works automatically, cuts the four sides at one operation, and carries the wood clear of the machine as it finishes. The felloe may be planed perfectly square or tapered towards the tread. In driving on the felloes, the wheeler should not use dowels more than $1\frac{1}{2}$ or 2 inches long, and for dressing the rims of hand-made wheels it is best to have the wheel fixed on a quickly revolving spindle, the rim running through a hand rest, upon which the workman's gouge or chisel may rest, which enables him to dress up the rim truly.

Figs. 52 and 53 show machines which impart a high

degree of finish, the effect of which is best seen during painting and varnishing. In the first, the wheel is placed between the cups, suspended by the hub, the rim being

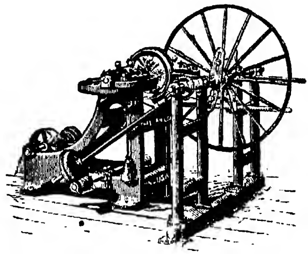


FIG. 52.—RIM-DRESSING MACHINE.

brought between the two sanding discs. One revolution completes the operation, during which the joints of the side are ground and finished. In the tread dressing machine the nave is placed on the mandrel, made to revolve, and brought up to the sanding disc, which grinds the tread flat and leaves a true bearing for the tyre.

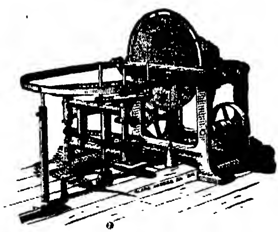


FIG. 53.—WHEEL-TREAD DRESSING MACHINE.

All wheels should have their spoke ends cut away with a gouge, to prevent them bearing on the tyre when the wheel is finished. The same may be said about the spoke ends in the nave. If the spoke ends rested upon the axle-box they would create noise when the carriage was running, and might fracture the box.

Our wheel is now ready for the smith to hoop, after which it is returned to the wheeler for boxing. The box-way in a nave is now very seldom cut by hand. Where there is no power machine, a hub-borer like No. 15 (fig. 45) is very often employed; but the wheel should always be centred from the rim, in order to insure true running, because if the hub has one side softer than the other, which is often the case, the contraction of the tyre will have such an effect upon that side as to throw the wheel out of truth.

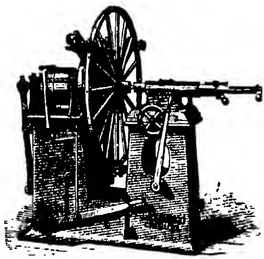


FIG. 54.—BORING AND BOXING MACHINE.

The boring and boxing machine illustrated has a self-centring arrangement, the rim being held perfectly true by the extension arms. The wheel is made to revolve at a high speed, and the cutter is brought up, and bores right through the hub, counter-boring for the back end of the box.

In some machine-made wheels wedging the box is entirely dispensed with, as the work is correct from the outset, and the hole in the hub being made a trifle smaller than the axle-box, the latter is forced in by a powerful screw, but in the majority of wheels it is necessary to wedge the box to get it perfectly fair in the centre, and this process being finished our wheel is ready for the stock-hoops and the paint brush.

We appear to be approaching a period of change in wheel construction. That change may be said to have commenced with the introduction of naves bound with

bands of iron, having mortises through which the spokes pass into the wood below. The "Warner" hub is an example of this style of wheel construction, and its success has been marvellous and not unmerited. The only valid objection that can be set against its many advantages is that such wheels always make more noise in running than the all-wood form. Wheels built on the tension principle, like those of bicycles, are now made for pleasure carriages, and it is probable that, with the improvements which are constantly being made in solid india-rubber and pneumatic tyres, we shall see the use of such wheels widely extended.

CHAPTER IX.

CARRIAGE SMITH-WORK.

Tools.—Body-plates.—Depth and thickness.—Fitting plates.—Pump-handles.—Wheel-plate.—Sway-bar.—Futchells and futchell-stays.—Wheel-irons.—Wheel-iron heads.—Transom-plate.—Perch-bolt.—Other bed-plates.—Horn-bar plate.—Front stay.—Boot-side and footboard plate.—Steps.—Seat rails.—Wing-frames and stays.—Lamp-irons.—Axles. Collinge and Mail patterns.—Lengths of arms and bushes.—Wrought-iron boxes.—Tyres.—Bending.—Heating.—Hooping.—Nave-hoops.—Springs.—Cutting steel bars.—Machine made springs.—Forging.—Open and close eyes.—Lengths of plates.—Tempering.—Grinding.—Finishing.—Fitting ironwork.

IT is not proposed in this place to deal with the arrangement of a coachmaker's smith-shop in the matter of fires, chimneys, etc., a subject upon which a great deal of discussion has taken place at various times. Conditions vary too much to permit of any particular plan being adopted by more than a few. There are many establishments where a spring or an axle is never made, where there is neither motive power, fan-blast, nor power tools such as a small steam-hammer, or a lathe, and where such work as turning an axle-arm could not be done. There is, however, one essential condition which can be observed in every coachmaker's smithy, large or small, *i.e.*, cleanliness. The chimneys must have a good draught, and every precaution ought to be taken to prevent smoke and soot filling the air, and finding its way into other parts of the factory; probably into the paint and varnish rooms, where its effects are highly injurious to the surface of freshly varnished carriages.

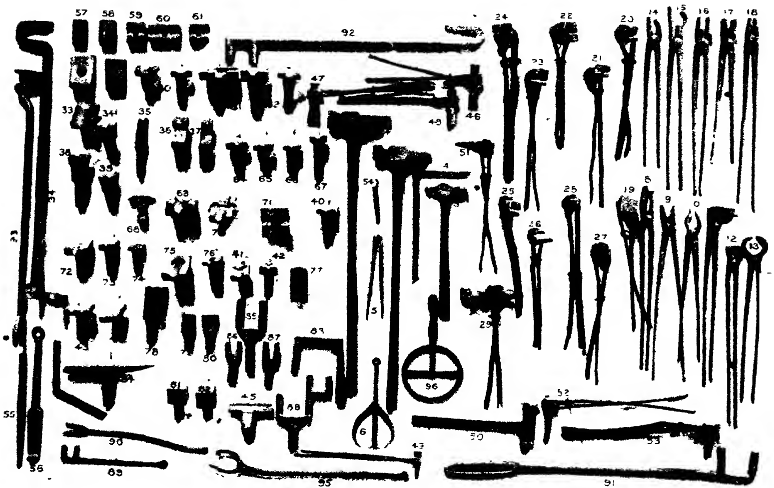


FIG. 55.—COACHSMITH'S TOOLS.

[*To face page* 124.

For many years "Breeze" has been used as fuel by smiths throughout the country. It not only conduces to the abatement of the smoke nuisance, but is much cleaner than coal to work with. If coal is employed, it should be as free as possible from sulphur and other impurities, which have an injurious effect upon the iron.

In small towns the smith must not only be able to iron the body and carriage, but to make a spring and hoop a wheel. It is very convenient sometimes to have ready-made springs in stock, but if a customer had an accident, and required a new spring back at short notice, the coach-maker would be in an awkward predicament if his smith were unable to make one.

The hand tools usually employed by a coachsmith are shown by fig. 55. This is a good average collection, but there are many intelligent men who take a pleasure in making what are termed "special" tools for particular kinds of work.

1. Fore hammer.
2. Quarter hammer.
3. Hand hammer.
4. Square.
5. Compasses.
6. Double callipers.
7. Bevel.
8. Box tongs.
9. Hollow jaw tongs.
10. Plier tongs.
11. Duck beak tongs.
12. Pincer tongs.
13. " "
14. Barrel socket tongs.
15. " " "
16. Flat jaw tongs.
17. Flat jaw tongs.
18. " "
19. Flat face.
20. Narrow round swage.
21. Collar swage.
22. Tee swage.
23. "
24. Cross stamp.
25. L or corner swage.
26. Fuller.
27.
28. Hammer fuller.
29. Axle flap swage.
30. Stud swage.
31. Wheel plate swage.
32. Oval Tee swages.

33. Oval swage.
34. „ „
35. Narrow round swage.
36. Cranked swage.
37. „ „
38. Double narrow round swage.
39. „ „
40. Cross swage.
41. Collar swage.
42. „ „
43. Bottom swage.
44. „ „
45. Extension swage.
46. Cold chisel.
47. Gouge chisel.
48. Hot chisel.
49. Slit chisel.
50. Set hammer.
51. Square rod punch.
52. Round, or bob punch.
53. „ „
54. Centre punch.
55. Hand mandrel.
56. Hind shaft-fastener mandrel.
57. Slit bolster.
58. „
59. Half-round scroll bolster.
60. „ „
61. „ „
62. Bevelled oval bolster.
63. Round bolster.
64. Bottom cross tool.
65. Bottom cross tool.
66.
67. L tool.
68. Button tool.
69. Front barrel stamp.
70. Step top stamp.
71. Front scroll stamp.
72. Spur tool
73. „ „
74. „ „
75. Step top stamp.
76. Shaft hook stamp.
77. Half round bolster.
78. Clip bending tool
79. Hardy.
80. Bottom fuller.
81. Square set.
82. „ „
83. Saddle.
84. Beak iron.
85. Twisting wrench.
86. „ „
87. „ „
88. Double scroll wrench.
89. Twisting wrench.
90. Slit „
91. Brake or step wrench.
92. „ „
93. „ „
94. „ „
95. Wheel-hooping wrench, or dog.
96. "Traveller" or tyre-measuring wheel.

To this list we may add a pair of iron "winding" sticks, a "float" or "rasp" file for hot iron, and a brass or steel 2 ft. rule.

In the table of proportional measurements given in the first chapter, the size of the landau edge plate is stated at 3 in. $\times \frac{3}{4}$ in. There are many body-makers and smiths who would prefer to use a plate $3\frac{1}{2}$ in. $\times \frac{1}{2}$ in., running to $2\frac{1}{2}$ in. $\times \frac{5}{8}$ in. at the front and with 8 in. tails up the pillars. If the canoe landau has a fairly long body—say 5 ft. 3 in. from back to front inside—then the plate might be $\frac{3}{4}$ in. thick. Of course, the deeper the plate the stronger it is, and depth is indispensable if there is much bevel on the rocker, as the plate is then thrown so much more out of a vertical line, and its resistance to the springing of the pillars is proportionately reduced.

Some body-makers object to the smith taking away the framing to fit his plates, but if reasonable care is used in the smith's shop it is much better to have the wood-work on a bench near the anvil. It cannot be denied that some smiths needlessly burn and injure the wood when fitting their plates. For instance, we may sometimes find a pair of wooden futchells which were so well and tightly mortised into the bed as to require a lot of driving home, become so slack as to be afterwards driven in with a pin hammer when the carriage-maker is dressing his work; the reason being that the smith has fitted the bed-plates when too hot.

The pump-handles for a landau like fig. 23 should be forged out of $1\frac{3}{8}$ in. square iron jumped at the shoulder and drawn down to the ends, which are forged to an ornamental pattern. Some builders weld a ready-made stamped end to the pump-handles. Too much length behind the spring clips should be avoided, it is useless and unsightly; so far as mere utility is concerned we might terminate the pump-handle at the end of the spring-block.

Iron measuring $1\frac{3}{8}$ in. square is given as the size, because $1\frac{3}{8}$ in. × $1\frac{1}{4}$, which is a better size for the smith, is not usually so readily found in stock. For the wheel-plate we use $1\frac{1}{4}$ in. half round iron, or $1\frac{3}{8}$ in. if the carriage is a strong one. Provided the wheel-plate is of large diameter with good bearings there is not much necessity for a sway-bar, but if one be used it should be part of a circle not less than 3 inches greater in radius than the wheel-plate, and of the same size of iron.

Extreme care is necessary in bending the two pieces of iron of which the circle of the wheel-plate is generally made, in order to preserve the edge of the iron uninjured, and to render it perfectly true on the flat side. Owing to the extension of the outside fibres and the compression of those on the inside it is very liable to injury. The inside futchell-stays may be of 1 in. round iron split and flanged, and from the stay to the ends $\frac{7}{8}$ in. square iron swaged down after it is welded on.

The wheel-irons can be made of 1 in. × $\frac{5}{8}$ in. oval, and the wheel-iron head can be forged out of $1\frac{1}{4}$ in. square iron if a bevelled head is used, or half round iron if the round head is preferred. The individuality of a coachmaker is more generally visible in his fore-carriages than in any other part of his work, and almost every builder has a particular design of wheel-iron head. Some use ready-made stampings, which are welded up by their own smiths.

In the case of the transom plate, which may be regarded as the principal strengthening plate of the fore-carriage, the socket for a $\frac{3}{4}$ in. perch-bolt should be forged out of $1\frac{3}{4}$ in. × $\frac{5}{8}$ in. flat iron, with $1\frac{1}{4}$ in. round welded on to make the boss; for the ends the iron should measure $1\frac{3}{8}$ in. × $\frac{5}{8}$ in. welded on to the socket piece.

We may forge the bottom plate of this bed $1\frac{3}{4}$ in. × $\frac{5}{8}$ in. at the middle, with the futchells welded on and $1\frac{1}{2}$ in. × $\frac{3}{4}$ in.

at the ends. The top bed-plate will be $1\frac{3}{4}$ in. in the centre, by $\frac{1}{2}$ in. feather-edge, the ends being $1\frac{1}{4}$ in. $\times \frac{1}{2}$ in. If the bottom plate is separate it will be made of similar iron, but many builders forge the bottom plate in one with the wheel-plate, while others make it separate, but weld a tail on the wheel-plate and carry it up the under side of bed to the dub end: this is a very strong form. The other plates in the fore-carriage are the horn-bar plate, a flat piece of steel $1\frac{1}{2}$ in. to $1\frac{3}{4}$ in. broad by $\frac{1}{4}$ in. thick, tapered to the ends; and the front or footboard centre-stay, which is usually $\frac{3}{4}$ in. $\times$ $\frac{1}{2}$ in. oval iron.

The remainder of the body ironwork consists of boot-side and footboard plate, for which half round iron 1 in. wide is used up the boot-side, and $1\frac{1}{4}$ in. up the driving-footboard, with the boot-step tread forged in the solid, or welded on if a grid-iron or fancy tread is used. For the driving-seat rail, round iron $\frac{7}{16}$ in. diameter is very suitable, and for the wing-frames $\frac{3}{4}$ in. oval. The hind wing-stays should be $\frac{5}{8}$ in. round at the flap, tapered to $\frac{1}{2}$ in.

The front wing-stays should be $\frac{1}{2}$ in. if made with a foot going on the top of the boot panel or under the boot. If they are bored straight through the boot-side, then the iron should be a little stronger, made with a round boss. The lamp irons are generally of $\frac{5}{8}$ in. round iron, that on the right side being welded on to the brake-rack. For the step shanks or stems, oval iron 1 in. $\times$ $\frac{3}{4}$ in. is generally used. The tee flaps should be of good length and properly bolted to the rocker. We are speaking of an ordinary step, and not a branch step or a long one with a weld in the middle of the shank.

Axles.—There are now very few carriage manufactories where the axles are received in the rough forging and turned, case-hardened and finished on the premises. The general practice is to order from the axle-maker an axle and boxes of a stipulated diameter and length, and merely

to fit the bushes into the nave; or to order the axle in two arms finished ready for welding to the required length, The art of the coachmaker, which formerly comprised a great variety of employments under one roof, is now losing some of its important branches in the system of divisional production which has become general. Springs, axles, wheels, iron and steel stampings, are now received ready-made from manufacturers who devote themselves almost exclusively to their production, and *coachmaking* in some places appears to consist of little more than assembling the various parts together and finishing the carriage ready for sale.

It is almost impossible to determine exactly the correct dimensions of a carriage axle, because of the various strains it has to bear when in use; and those strains must be guarded against. If a horse runs away, or the carriage comes into collision, strains are experienced quite beyond calculation. This remark applies to all parts of the carriage, but more particularly to the axle. Steel permits us to reduce the size and consequently the weight of the axle, and the arm is more readily hardened, but owing to the conditions to which a carriage axle is exposed in running, the accidental shocks it is called upon to bear and the vibration to which it is subject, steel, however mild, is not so reliable as good fibrous iron. The majority of axles have solid flaps, which should always be forged in the solid with the arm. Some builders object to a welded flap, because it is welded with its fibres at right angles to those of the arm, and consequently the weld is sometimes faulty. Cranked axles with the flaps above, in a line with, and below the arm, are more commonly used on vehicles of all kinds in France than in England; but whether an axle be cranked or straight, the flaps and collars can be forged in the solid and should always be so, because there is then no fear of a faulty weld, and the axle is stronger.

The two forms of axle used for pleasure carriages in the United Kingdom are the "Collinge" (fig. 56), and the "Mail" (fig. 57).

In the matter of the length of bushes, etc., for an axle arm of a given diameter, there is considerable variation in

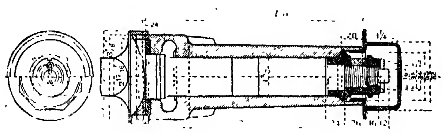


FIG. 56.—"COLLINGE" AXLE.

the practice of different makers. The "Collinge" axle illustrated shows a $1\frac{1}{8}$ in. arm, and bush of the standard sizes recommended by the Axle Committee and Council of the Institute of British Carriage Manufacturers.

The reasons that determined these proportions are, that

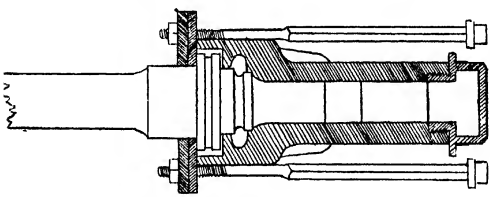


FIG. 57.—"MAIL" AXLE.

a long axle-box runs more silently than a short one; but long axle-arms and boxes, by their leverage in the wheels in use, have a tendency to break an axle.

The length of the box is $8\frac{1}{2}$ in., but many axle makers would prefer a 9-in. box for a "Collinge" arm of that

size. Approximately, the length of an axle-box should increase by $\frac{1}{2}$ in. for every $\frac{1}{8}$ in. increase in the diameter of the arm. Thus, if a 1 in. "Collinge" axle has a box $7\frac{1}{2}$ in. long, a 2 in. axle will have one $11\frac{1}{2}$ in. long, and if a 1 in. "Mail" axle has a bush $6\frac{1}{2}$ in long, a 2 in. "Mail" axle will have one $10\frac{1}{2}$ in. long. Such axles as the "Leeds," and the ordinary nut axle commonly seen on the cheap American carriages, are not admissible in good work.

The "Mail" axle is strong and safe, because if the arm should break at the collar—the usual place of fracture—the wheel would still be held on by the nave bolts passing through the loose collar. For smooth-running properties, however, it is not so good as the "Collinge," with its collet, right and left-hand nuts and oil cup. The collet is an adjusting cone by which the end pressure of the box against the collar can be very nicely regulated, and as this form of axle has the peculiar action of feeding itself from the oil in the caps, and thus runs more smoothly than other kinds, it is always employed in good work all over the world, and is an English invention, Mr. John Collinge having taken out his patent in March, 1811. Wrought-iron axle-boxes are to be preferred, because they are lighter and thinner than those of iron; they are not liable to fracture when being driven into the nave; they do not take up so much room; and they give a better surface for case-hardening. Smiths have various styles of welding an axle, but the plain scarfed lap makes as good a joint as any, and if the proper heat is reached, the workman soon feels whether he is sure of a good weld. Setting the axle to the road is work that demands great care on the part of the smith, for, the true running of the carriage depends upon it. If an arm is properly set to correspond with the dish of the wheel, *i.e.*, to secure a "plumb" spoke, the wheel will run truly without causing needless friction of the arm, the box, or the collet,

friction that generally results in the axle heating and becoming "set."

Tyres.—In measuring the wheel for its tyre, the smith carefully runs the former along the bar of iron, marking the position of the rivet holes, and making due allowance for the contraction in the length of the bar when it is bent. The work is all the more satisfactory if he has a roller machine to bend the bar of iron to an exact circle, because the fibres of the iron are not so much strained as when it is bent by leverage round a segmental block, and the flat place so often seen after welding is avoided. The wheel and tyre are afterwards run round with a traveller, or measuring wheel like No. 96 on fig. 55, to test the correctness of the measurement. The amount of joint-way in the felloes, or rims, to be drawn up close by the contraction of the tyre in cooling, should be carefully noted before the hoop is welded, as it varies in almost every two wheels. The allowance made on this account varies from $\frac{1}{2}$ in. in a small wheel to $\frac{7}{8}$ in. in a high one. The ends of the bar are scarfed, and given a little spring to keep them together in welding. If there is much bulging of the edge in welding, it should be trimmed off with a chisel instead of being hammered back. Steel tyres were formerly treated with some distrust by smiths, as they were usually difficult to weld, but the mild steel now used—it can scarcely be called steel—is almost as easily worked as ordinary iron, and we seldom hear of difficulty in working it. The rivet holes should be drilled before the tyre is put on, in the case of felloes one near each end of the felloe, and for bent rims one rivet hole between each spoke. An upright tyre-heating furnace with rolls worked by a handle on the outside is the best, as the hoops rest on the rolls, and by means of the handle can be gradually turned round until all parts have reached an uniform heat. The tyre should be a dull or black red all over when brought out, not red-hot in one

part, and black in another. Bent rims do not require the tyre to be so hot as is necessary in the case of short felloes, because so much "draw" is not needed. If the tyre is red-hot, the sole of the felloe or rim is burned, and the charred wood eventually works out, and the tyre needs contracting in a short time. The hooping platform should have a well-planed wheel-plate upon which the wheel is held through the nave by a screw-cramp, and when the tyre is in position the plate is sunk into a tank of water, so that cooling and contraction proceed equally all round. It is generally necessary to set the felloes or the tyre a little when the wheel has been hooped, and this should be done with a mallet, not with a heavy hammer, which leaves marks and bruises that are difficult to efface.

Many builders use ready-made front nave hoops, with a beaded or milled edge. Being produced by machinery they have a more finished appearance than a hand-made hoop, which is always difficult to weld neatly. The front hoop may be driven on cold, as it has nails to hold it, but the back hoop should be shrunk on when hot.

Springs.—When cutting off lengths of spring steel from the bar, the smith has to remember four things; viz., the camber or compass of the spring, the allowance for jumping the ends, and for turning the rolled eye, and the variation in the length of the plate given in drawing-down the ends.

The compass may require an addition of $1\frac{1}{4}$ in. in a spring 36 in. long, with a camber of 9 in. and a rolled eye from $2\frac{1}{2}$ in. to $4\frac{1}{2}$ in, according to whether we employ india-rubber covered bolts or not. In machine-made springs the plates are cut by shears, which form one part of the spring-making machine. The bolt hole is drilled in the centre of each and the plates are heated in a coke or gas furnace when the ends are drawn down by eccentric rolls, the nibs stamped, and the ends cut by shears to the

required pattern. This is but one of several processes that make a machine-made spring superior to one made by hand. The plates are not marked and distorted by hammering, and as they have equal bearing one upon the other, the spring, when put together, works evenly throughout its length. The heads are forged in a special machine by a series of stamps and dies, and are then welded on to the plate. Owing to the methods of forming the heads, and of welding them to the plate, they are liable to injury when the back plate is being set; the chief cause being that the head and the plate may have different welding heats, and one may be burnt while the other is not hot enough.

The best, and the most general way of making an open eye at the forge is to weld a clip of good iron on to each side of the plate, and to turn them over for the eye, dressing it off after the holes have been made. The same method may be employed in forming the box-eye of an elliptic spring, turning over the clips and bringing them round with the fuller to the cylindrical form. The second plate is made to come well up over the eyes in the "back" plate, in order to support it uniformly throughout its length, and the lengths of the other plates should be spaced off in a regular decrease down to the bottom, deducting an inch or more for the drawing down of the ends, the object of which is to make the spring deflect equally throughout its entire length when the load is applied. With this object in view, we draw the plate or gradually reduce its thickness from the point where the next plate ends. The slots in which the nibs work should measure 1 in. long × $\frac{1}{4}$ in. wide, and, in the top half of the spring, should be covered to the extent of at least one inch by the overlapping leaf, care being taken to see that each nib is in the middle of the slot.

The usual method of tempering spring-plates is to heat

them to redness, then to give them the "compass" required —each plate having a "spring" upon the one below—and afterwards to dip them into a tank of water which should not be quite cold. They are then "brought back" or detempered by being re-heated until they will burn wood, an old chisel-rod or hammer-shank being the most convenient and effective thing for rubbing along the plate to test the degree of heat. They are then allowed to cool slowly. Tempering with oil or tallow is said to give better results, and is done in various ways. A rough-and-ready method is to coat the plate with tallow and heat it evenly until the grease blazes off, repeating the operation a second time if necessary.

All springs require adjustment with the hand-hammer or, better still, a twisting-wrench if it be cleverly handled, to correct the twisting of the plates that takes place while they are being tempered; and the eyes invariably need the same treatment. This must be done quickly, when the plates are warm, and with as little hammering as possible. In grinding spring-plates a plentiful supply of water should be used, in order to keep down the heat, otherwise the temper would be injured. The slots must be carefully dressed and the nibs fitted. Where the plates have not been reached by the grindstone, they must be filed, and if an emery wheel is available for finishing, the appearance of the spring is very much improved.

When the plates have been carefully greased and the spring put together, it ought to be subjected to some simple but reliable test to ascertain that it is not soft or weak, and that it retains its flexibility. This may be done by means of a simple lever machine before the spring is handed to the carriage-maker, but it is often deferred until the carriage is mounted and loaded as indicated in Chapter II.

The most elastic and reliable springs are hand-made almost throughout, but they cost nearly twice as much as

those made by machinery. By the use of machinery, combined with skilled hand-labour, there is no reason why the best and most elastic springs should not be produced more economically, with equally good results, if the best quality of spring steel is used.

Coach-fitters or vice-men might, with considerable advantage to themselves, endeavour to attain a somewhat higher standard of accuracy in their work. It is not expected, nor is it necessary, that they should work to a one hundredth part of an inch, as fitters in some trades have to do, but one too frequently observes carriages of which the ironwork would not bear a critical examination by a person accustomed to other classes of fitting. Some smiths produce forgings of a far higher character than others, and the ironwork made by one man may not require half the filing needed by work produced at an adjacent forge, but there is absolutely no excuse for a vice-man who gives the ironwork a coat of lead colour in order to hide bad work or defects that have never been touched by his file.

The clips securing the springs should fit closely in the cut of the wheel-iron head and pump-handle after these parts have been lined with thin leather to give a "grip" and to prevent noise, which would arise from the contact of iron with iron. Bevels and angles should be clean and squarely cut, and such parts as the wheel irons, wheel-iron heads, and futchell-stays should be draw-filed if a high standard of finish is aimed at. The emery wheel is a valuable assistant in the production of well-finished work, and particularly ironwork that has been ground on the stone. So useful is this tool that it has been called "the best fitter in the shop."

CHAPTER X.

CARRIAGE PAINTING.

Care necessary in painting.—Prepared colours—The colours, varnishes, and other materials used in the paint shop.—List of coach-painter's tools. Care of varnish-brushes Painting a Brougham. Priming and filling-up.—Stopping—Rough-stuff.—Rubbing-down.—Facing.—Patent filling.—Painting the carriage lake colour. Varnish-colour.—Undercoating varnish.—Flatting.—Picking-out and striping.—Varnishing—Painting the under-carriage.—Heraldry and Monogram-painting.—Encouragement for young painters to acquire the art.

WE have now reached the finishing stages of our work, the decorative stages of painting and trimming, which either "make or mar" the carriage in regard to attractiveness and readiness of sale.

When a body-maker turns over a perfectly constructed and highly finished piece of work to the painter, he expects that the latter will bestow upon it all the care and ability of which he is capable, for a carriage owes much of its character, and its power to please the eye, to the manner in which it is painted. It is in the painter's power to bring into prominence all that is graceful in the outline of a carriage, and to suppress, or, at any rate, to soften, that which may appear out of harmony with the general design, so that when the carriage is finished, and placed in the show-room, it may attract the attention and admiration of intending buyers. It is not a general rule, but it frequently happens, that the painter does not evince due regard for the finished productions of other men, and that good work is spoiled by carelessness in treatment, or hurry in finishing. The charge of disregard for the work of

others applies to other men in a coach factory as well as painters, for how often may we see a carriage-maker, while hanging a newly finished body, carelessly throwing hammers, wrenches, and similar tools, upon the smoothly varnished footboard.

It is always desirable that a workman should know something of the origin and the nature of the materials which he uses, and for that reason the painter should be acquainted in some degree with the origin and classification of colours, the chemistry of paints, and the processes of preparing pigments. If wishful to obtain a thorough knowledge of this kind, he may profitably study a work on the subject by MM. Riffault, Vergnaud and Toussaint, or one by Church on the chemistry of paints and painting. For practical purposes, however, he will find in the admirable little "Handbook for Coach-painters," written by Messrs. Simpson and Thrupp, a fund of information, pleasantly and plainly imparted, which he should carefully study if he desires to excel.

Prepared colours are now very widely employed by coachmakers, and where they are used the young painter misses much valuable training in the art of mixing and matching. It is a well-known fact that some colours are completely spoiled, unless the grinding is carefully and thoroughly performed, and, of course, where a good paint-mill is not within reach, the prepared colours are most useful. They are usually impalpably fine and pure in tone, and when applied quickly with a camel hair brush they dry without any defects. Some of them, however, dry too quickly; owing, no doubt, to the powerful dryers used in the grinding. The result is, that they frequently crack under the varnish in the same way as a picking-out line of turpentine-black commonly does. If care is taken to exclude the air by covering the colour with turpentine they are economical.

The following is a list of the colours, varnishes, and other materials usually kept in a coach-painter's shop:

Raw-umber.
Burnt-umber.
Raw-sienna.
Burnt-sienna.
Vandyke-brown.
Lemon-chrome.
Orange-chrome.
Yellow-lake; used for enriching greens by glazing.
Carmine.
Vermilion.
Crimson-lake.
Purple-lake.
Rose pink.
Dutch-pink.
Indian-red.
Venetian-red.
Brunswick-green.
Royal-green; three shades.
Ultramarine-blue.
Prussian-blue.
Cobalt-blue.
Ivory-black or Drop-black.
Lampblack.
White-lead; ground in oil.
White-lead, dry.
Flake-white.
Prepared filling-up powder: if the old fashioned and reliable filling of ochre and white lead is not used.
Linseed-oil; raw and boiled.
Turpentine.
Undercoating body varnish: for preparing the work, and making varnish colour.
Flatting body-varnish.

"Finishing" or "wearing" body-varnish. A special finishing body-varnish is made for use in paint lofts where there is not a proper system of warming.

"Hard-drying" carriage varnish: for "bringing-up" the work.

Elastic carriage varnish: for finishing wheels and under-carriage parts.

Quick jobbing-varnish.

Black-japan.

Black-lacquer: for jobbing and quick drying.

Japan-gold-size.

Pale-gold-size.

Terebine-dryer.

Fine powder pumice-stone; in various grades of fineness.

Prepared pumice-bricks.

As "order and economy" should be the watch-word in every department of a coach factory, so should "cleanliness and care" be the coach-painter's motto, and particularly in the matter of his tools, of which the following is a list:

Two dusters: one for rough work, and one for finishing.

Round priming brush, sash and flat tool.

Filling-up brush, sash and flat tool.

Colour brush, sash and flat tool.

Colour brush and flat sash tool for light colours.

Black brush and tool.

Oval body varnish brush and two tools.

Oval carriage varnish brush and two tools.

Japan brush and tool for body.

Japan brush and tool for carriage.

Japan tool for jobbing.

Sable picking-out pencils; three sizes.

Sable edging and fine-lining pencils; two sizes.

Three or four swan-quill pencils for turpentine-black, japan, etc.

Set of "lettering" and "heraldry" pencils.
Putty knife.
Plastering knife.
Palette board and knife.
Paint pots; four sizes.
Varnish brush-holders.
Mortar and pestle.
Marble slab and muller; stand cased with sheet zinc to promote cleanliness.
Compasses and chalk-line.
Paint mill.

It would be impossible to lay too much stress upon the necessity for care in keeping brushes, and especially varnish brushes, clean and in good order. A body-brush should never be used for carriage parts, and all varnish brushes should be carefully cleaned out after use, and placed in specially made tins, where, by means of a wire through the handle, they are suspended in varnish without the bristles touching the bottom. An admirable tin for this purpose was designed by Mr. John Robertson, of Glasgow, and there are now a number on the market, but some makers, in their anxiety to exclude dust, have neglected ventilation, and as there is no escape for the fumes of the varnish which evaporates, the handles of the brushes become sticky, and most uncomfortable to work with.

Coach-painting is a tedious process, and by those not acquainted with the subject, the time taken to paint and varnish a carriage is regarded as unnecessarily long. Of course the coach-painter can perform miracles in the way of turning out work in as many days as he ought to have weeks, but there is a corresponding difference in the durability. The process of coach-painting as carried on to-day is, in most respects, the same as it was fifty years ago. Many attempts have been made to shorten the period by the introduction of quick-drying materials for filling the

grain of the wood, quick-drying paints and varnishes; but the repeated trials of such preparations have only emphasized the fact, that a due allowance of time for drying is absolutely necessary if the work is to be durable and satisfactory. Chemists may ultimately be able to give us a substance which will enable us to perform the work in a much shorter time, and yet obtain satisfactory results in the shape of a durable non-absorbent ground-work and a brilliant surface. Coachmakers will welcome the introduction of such a process.

A carriage is painted not merely for the purpose of ornamentation, but to preserve it, and we therefore fill up or hide the grain of the wood, so that it may not be visible, and may not absorb the coats of colour and varnish with which we finish the work. Otherwise the carriage would lack that brilliant surface which we aim at producing. It is necessary, also, that the first coats applied to the wood should be somewhat elastic, so that they may not crack or flake away from the wood underneath, when its natural action causes it to slightly expand or contract from changes of atmosphere, natural or otherwise, *e.g.*, an overheated coach-house.

To illustrate the process of painting a carriage, we will suppose that a brougham has to be painted lake, or claret colour.

In most cases the body-maker will have sandpapered his work very carefully; but, before commencing operations, the painter should satisfy himself that all asperities have been removed from the surface. The body must be cleaned out, and thoroughly swept with a painter's duster, after which it should be what the Americans term "slushed out," *i.e.*, painted inside with lead colour, or any good oil colour containing lead, to enable the panels to resist atmospheric changes; especially in a country like England, surrounded by water.

To fill up the pores of the wood the body is primed with white lead and raw linseed oil, the mixture being thinned with turpentine, and a little gold size added as a dryer. Boiled linseed oil dries much quicker than the raw oil, but it becomes gummy and thick. In speaking of white lead, we mean unadulterated lead ground in oil, and supplied in that form by the makers. Dry white lead is merely used in making hard or soft putty, or turpentine colour.

The priming should be applied thinly and evenly with a good stiff brush, the paint being worked well into corners and pin-holes. For drying, four days at least are necessary, but a week is better. For the second coat some painters use white lead ground with oil and japan gold size in equal parts, and thinned with turpentine. Two coats of priming is the number usually given to ordinary work, but three or four may be applied if a particularly fine finish is aimed at.

All pin and nail-holes must now be stopped; the material called "stopper" being a putty composed of dry white lead and gold size, or white lead and varnish. It must be very carefully worked home into each hole, a little at a time, allowing one piece to dry before another is pushed in. It serves no good purpose to fill a hole above the surface. It should be stopped until it is level with the wood. The showing of pin-holes after a carriage is varnished, or has been in use a short time, is a defect too well known to every one connected with coachbuilding. It is a fault that can be overcome only by careful stopping and careful painting in the priming and filling-up stages.

The roof and quarters are covered with a russet hide, and when the trimmers have finished sleeking it on, sufficient time must be allowed for drying thoroughly before the leather is primed.

We cannot apply oil paint to the hide, and we therefore prime that portion of the body with two or three coats of

japan gold size, or a mixture of japan, white lead, and gold size for a dryer. This sort of priming dries hard, and offers a non-absorbent surface upon which to lay succeeding coats. The gold size priming will of course dry well in a day.

For our "rough-stuff," or filling-up mixture to hide inequalities of surface, we take two parts of filling-up powder to one part of white lead, three parts of varnish and one of japan gold size, the whole to be mixed on the slab as stiff as putty and thinned down with turpentine. This filling-up works better when it contains as much turpentine as there is varnish and gold size. Six coats of filling-up are given, one day being allowed for each to dry thoroughly. The work can be done quicker, but it is not desirable or advisable. The filling-up is followed by the "staining" or "guide" coat, which may be either yellow ochre or Indian red, mixed with turpentine and gold size. It is employed to guide the workman in rubbing down the filling to a level surface all over; as when any of the colour is left, it indicates that the body has not been rubbed sufficiently at that spot.

Pumice-stone bricks and a plentiful supply of water ought to be used in rubbing, and care must be taken not to scratch or cut down into the paint, as it is scarcely possible afterwards to eradicate such marks completely. Dub-ends etc., should be tied up in paper or cloth to protect them from injury.

When the body has become perfectly dry it should be rubbed over with very fine glass-paper, all corners, beads and mouldings receiving attention. After a good dusting the work is ready for a coat of lead colour, called the facing coat, and when this is dry the body is again faced with pumice stone. "Facing" is not so laborious as "rubbing down" and if the work has been properly performed up to this point we have a fine even surface, ready to receive the

coats of colour. At this stage some coachmakers prefer that the body should receive a coat of patent filling, which is rubbed off again, and it is a very good plan, because it fills up the porous ground coats and holds out the succeeding coats of colour and varnish in such manner that, when finished, the work has a full and brilliant appearance.

Our carriage having to be painted lake, we now apply a coat of oil black, and many painters would follow this with oil brown, composed of Indian red and black, next with a coat of rose pink ground in oil, and then with a coat or two of lake, ground in oil, the number depending on the quality of the work.

The next application is varnish colour, *i.e.*, lake ground with varnish; and when this is dry the coloured parts are flatted with finely powdered pumice-stone on a cloth pad. Corners must be carefully gone into, and it should always be borne in mind, that whenever pumice-stone is employed there should be a liberal use of the water tool to wash it out of corners and grooves.

When the body has been washed, and is thoroughly dry, we proceed to give the black parts a coat of oil black, and when that is dry the black parts are japanned and the coloured parts receive their first application of undercoating body varnish. The work is then flattened all over and very carefully washed; for if pumice-stone dust is permitted to lurk in corners, the varnish brush will inevitably find it out afterwards and deposit it in a more conspicuous place. When the body is dry the black parts are japanned and the coloured parts receive another coat of "hard-drying" or "undercoating" varnish. The flattening process is again repeated, and is followed by japan for the black parts and varnish for the colours. The body is again flattened, the black parts are japanned, and the picking-out lines put on. Picking-out and striping are things which can only be learned by long and patient

practice. An apprentice coach-painter may spend years before his hand and eye acquire the desired dexterity; but he must not be disheartened, for so much depends upon the proper performance of this work for bringing into relief the design of the carriage.

The whole of the body is again flatted and receives a coat of varnish, after which the process is repeated with, if possible, increased care, and it is ready for the edging lines. When everything is hard and dry the work is cleaned off in the most searching manner, and is then ready for the most critical process—the final varnishing.

Volumes have been written on the subject of varnishes and varnishing, yet we appear to be far from perfection in making and applying the liquid. Some varnishes, after being put on, pit or crawl; others bloom or cloud, and have other irregularities, but it is very probable that we should hear less of the vagaries of varnish if nothing but that of a good quality were used, and if it were rationally manipulated. If we apply a coat of varnish to a surface that is not hard, dry, and clean, we cannot expect satisfactory results, nor is it possible for a carriage to look well when it has been varnished in a cold, damp, or dirty room. The whole of the surfaces should be scrupulously clean, and should be wiped with an old silk handkerchief before the varnishing begins. The tools must be clean, and kept so while the work is going on. The varnish-room should be constructed specially with a view to exclude dust; it must be clean, properly lighted, ventilated, and heated; and the varnish and the carriage should be as nearly equal in temperature as it is possible to make them. The skilled varnisher should exercise great care in relation to the cleanliness of his person and clothing. If these precautions are observed, and if a first-class varnish is used, and no attempt is made to mix it or to hurry it, we may reasonably expect, and shall very seldom fail to find, a well-finished carriage when the

varnish is dry and the doors are opened and the work is drawn into a light place to be thoroughly examined.

The best varnish for carriages that the world produces is made in England. Its superiority is admitted even in France and America, but our varnish makers have not yet been able to give us a perfectly clear coach varnish that does not affect the tone of the colours underneath. The tendency of carriage varnish is to give a green hue to blues and to turn white into yellow, and it will cause the best black japan to appear dark green in some lights. It is almost too much to expect an oil varnish to be durable and yet so pale that it will not injure the most delicate colours, but no doubt our varnish makers and their chemists will some day solve the problem. We must not blame the

DURABILITY OF COLOURS.

Pigment.	Years of Exposure	Residual Depth: original = 10	Change of Hue.
Yellow ochre	5	10	Browner. More translucent.
Aureolin .. .	5	9	None.
Indian yellow	5	8	Slightly brownish.
True Naples yellow	5	10	None.
Pale yellow madder	2	7	Greyish salmon when mixed with flake white.
Deep yellow madder	2	6	Dirty pink when mixed with flake white.
Scarlet lake . ..	5	7	Dull pinkish red.
Crimson lake ..	5	1	Almost gone.
Madder red	2	10	None.
Madder carmine ..	5	9·5	None.
Madder brown ...	2	9	Rather duller.
Prussian lilac	5	8·5	Slightly greener.
Indigo	5	8	Slightly greener.
Artificial ultramarine.	5	10	None.

varnish for all the deterioration which may occur in the colours we employ in coach-painting. Some of these colours are fugitive in character, and unless they are obtained from reliable makers, there is always a doubt about their quality.

The author of the "Chemistry of Paints and Painting," Mr. A. H. Church, made a series of trials of oil colours by exposure to all the light he could obtain, and some of his results, given on the preceding page, are of value, not only to artists, but to coach-painters and others.

The painting of our undercarriage has, of course, been progressing at the same time as that of the body, the coach-painter always trying to keep one piece of work progressing at the same rate as the other. The processes, however, are different. The dressing of the wheels, and the sandpapering of the carriage parts before any paint is applied, is work that does not occupy much time, but any extra trouble bestowed upon it is amply repaid in the finished job.

The wheels and undercarriage are first primed with a coat of oil lead colour, *i.e.*, white lead, lampblack and linseed oil, thinned with turpentine, and a little gold size for a dryer. This should not be hurried in the drying, and when the work has been sandpapered and cleaned off, it receives a second coat of lead colour. The open-grained parts are then filled with putty (or soft stopper), but it is far better in every case to fill up in the ordinary way the rims and the naves of the wheels, and any other wood that is coarse-grained, with two or three coats, and then to rub them down. The result is always worth the trouble. The use of turpentine lead-filling should not be permitted, for it is most inimical to the health of the workman who inhales the lead dust which flies from the work, and it is only a slip-shod fashion of coach-painting.

A third coat of lead colour is followed by a careful rubbing with glass-paper, and then a coat of oil black the succeeding coats being oil brown, rose-pink, and lake to

correspond with the body; after a coat of varnish the work is flattened and picked out. A second coat of hard-drying varnish is followed by rubbing, and then the striping. Nave hoops, axles, and other parts having been blacked, the work is ready for the last coat of varnish. Axles, steps, brake-work, etc., must be very carefully blacked japanned, and varnished, and when the body is hung, those parts which the carriage-maker has been working at, eye-bolts, etc., require to be touched up before the carriage passes into the show-room.

During recent years the art of heraldic painting has been neglected by young coach-painters, and there has been a scarcity of men capable of emblazoning armorial bearings on carriages. Efforts have been made by the Institute of British Carriage Manufacturers to revive the interest of coach-painters in the subject, and those efforts promise to be in some measure successful. The use of armorial bearings on carriages is not so general at the present time as it was forty or fifty years ago, while on the other hand the use of monograms on carriage panels is increasing.

We need not stop here to inquire into the causes of what has been termed "the decline and fall of the Heraldic Empire." There is still a wide field for the young painter who is endowed with a thoroughly artistic temperament, and who is willing to devote a portion of his leisure to drawing and painting in oils. It is not necessary that he should have any deep knowledge of the science of heraldry, and its literature. He will, of course, have to acquire an acquaintance with its symbols, but that is not difficult, and if his tastes incline in the direction of art, and he is endowed with ability and perseverance, he will in time be able to portray heraldry with all the effect that is necessary, and with what is more important, exactness of detail. When he has demonstrated his ability to do this, his success in the higher branches of coach-painting is assured.

CHAPTER XI.

CARRIAGE-TRIMMING.

"Trimming" an art.—Messrs. Thrupp and Farr's text-book.—Some examination questions.—List of trimmer's tools.—Materials used in lining and trimming.—Cloths, silks, velvets, etc.—Leathers, carpets, laces, fittings, etc.—Stuffing materials.—Quantities of materials to trim a brougham and a landau.—Cutting leather for heads and aprons.—The sewing machine. Trimming a landau.—Carriage furniture.—Beading.—Lamps, plated, and other fittings.

IN this place we would like to bespeak for the work of the coach-trimmer a somewhat higher place than it usually occupies in the estimation of those engaged in other branches of the trade.

It has been truly said that the trimmer must quilt like an upholsterer, stitch like a harness-maker, and sew like a tailor, and it is just as necessary that he should have good taste and a knowledge of design, proportion and colour. The materials which he uses are the most costly of those employed in the carriage-factory and require great care in storage and in working, to avoid waste.

The cloths, silks, laces, etc., employed for coach-trimming in Great Britain are much more sombre in colour than need be, but the taste of the carriage-user lies in the direction of dark colours, both in painting and lining, and were it not for the light lines of relief customary in the painting and in the laces, the modern pleasure carriage would convey to the ordinary mind an impression of gloom. In some foreign countries a more cheerful, and what some people would consider a more artistic, style of trimming is usually

aimed at; brighter coloured fabrics are commoner than with us; but even in France and America the subdued colours and the quiet, simple taste characteristic of the English carriage has made itself felt, and is now more or less followed in those countries, because it is not the object of persons of refinement to copy the colours of the peacock, but to provide a suitable background or setting for the lady owners or occupants of the carriage.

The coach-trimmer has, above all things, to adapt his work to the comfort and convenience of the carriage-user; the design of his lining in the matter of quilting, pleating, fluting, etc., is a secondary consideration. He avoids using materials with a large pattern, particularly if the lining has to be quilted, because the pattern becomes confused in the working; nor should he give the lining a crowded appearance by forming a number of very small squares or diamonds closely buttoned or tufted.

Those acquainted with the working of our technical classes have had occasion to remark that the proportion of trimmers attending them has been much smaller than that of the other branches of the trade. Happily, young trimmers are now taking greater interest in a subject which is so vitally important to them, and their attendance at the classes is more gratifying to the managers and teachers. Coach-trimming is not a mere mechanical operation, it is an art, and Messrs. Thrupp and Farr did something practical for the improvement of the art in this country when, at the instance of the Coach and Coach-harness Makers' Company, they published their handbook on the subject. They describe some parts of the trimmer's work in "very elaborate detail," as "it shows the principles that underlie the ordinary methods, and is suggestive of variations which any ingenious trimmer can turn to account." The authors do not intend to teach the craft of the coach-trimmer by itself, but to assist the young man who has already entered a

factory to improve and increase his knowledge, and this is, of course, the principal object of a text-book.

The following are a few examples of questions set for trimmers by the examiners of the City and Guilds of London Institute, and a good text-book will enable the young candidate to answer them with greater certainty and precision than by merely relying on the experience he has gained in the particular shop in which he may be engaged.

1. Give a list of the materials generally used in trimming carriages.

2. Give a list of the tools used by coach-trimmers and leather-workers.

3. Does thick or thin leather wear best for heads, wings, linings, braces, etc.? Which looks best made up? Which cracks, wrinkles, or gets out of shape, or breaks first?

Suggest possible defects in the material and the remedies?

4. Describe the best method you know of putting loose horse-hair into a lower back squab of a brougham to fill it?

The trimmer does not require a tool-box as large as a body-maker's, but the implements with which he works are somewhat more numerous than is commonly supposed. The following is a fair average list:

Awls: straight, brad, closing and garnishing.
Bolster-iron.
Creasers: single and double edge.
Creasing and embossing machine.
Compasses: ordinary and channelling.
Claw-tool.
Chisel.
Draw-gauge.
Door rest.
Edge tools.

Hammers, with and without nail claw.

Knives: large, round head, curved head, and square pointed.

Mallet.

Needles: ordinary sewing.

Needles: three-cornered harness.

Needles: bent.

Needles: tufting or quilting, single and double eye.

Nail-box.

Nippers, cutting.

Pincers.

Pliers.

Punches, set of round and oval.

Punch-gauge.

Punch-block of lead.

Pricking-wheels.

Pinking irons: straight and half round.

Paring-tools.

Rule (pocket).

Rail leather holder.

Sewing-machine.

Shears: bent and straight.

Spokeshave.

Straight-edge.

Screw-drivers.

Square.

Scalloping-wheel.

Splitting-knife. A remarkably handy little machine for splitting leather down to a suitable thickness for welting.

Straining fork and jack: for stretching webbing, etc.

Slicker.

Stuffing-sticks.

Thimble.

Tufting-block. This article should be abolished: if a cushion cannot be tufted without it, the cushion is too hard.

Tape measure.

Yard-wand.

The materials used in lining and trimming a carriage are more numerous than those employed in any other branch. They comprise:

WOOLLEN CLOTHS of various colours, and with both dull and bright surfaces. The best cloth obtainable is made in this country, and is known as "West of England." Blues, greens, browns, drabs and clarets are the colours in common use, but occasionally we might profitably employ the beautiful gray tints to be found in the linings of some French carriages.

SILK in the form of lute-string for blinds, and in taborette. The latter is not now used so much as formerly, on account of its not wearing so long as morocco leather, the raised pattern being readily worn off the surface.

SATINS, SILK PLUSHES, and VELVETS are used in place of cloth (though not often). They impart a very elegant appearance to the interior of a carriage, and would no doubt be more widely employed if they were of a more lasting character.

LEATHER.—Morocco goat-skins dyed in various colours, and finished with both dull and bright grain.

Roans or sheepskins dressed to imitate morocco are used for common work.

Enamelled sealskins:—these are very large hides of good serviceable leather, moderate in price, and suitable for trimming gig rails, etc.

Enamelled leather, ox-hide, No. 1, is the best in quality, and having the finest grain is used for covering the folding heads of landaus, landaulettes, barouches and phaetons.

No. 2 enamelled leather, ox-hide, has a coarser grain, and is commonly used for aprons. The number of the hide represents not only size, but quality of fibre, and freedom from defect. According to Fitzgerald, a No. 1 enamelled

hide may measure not more than 50 feet, while a No. 2 may measure more than 75 feet. The general rule is to classify hides of 55 feet and upwards as No. 1, provided they are fine in quality, and have no blemishes, warble holes, or cuts made by the butcher in flaying.

Border hide, ox-hide, is a heavy hide of japanned leather, used for driving-seat borders, valances, knob-roller caps and bottoms, etc.

Bag hide is that side of the split hide which is japanned on the grain, or hair side, and is used for covering dashers, wings, etc.

Split hide which is japanned on the flesh side is used for common work.

Some of those split hides are stretched so much before japanning, in order to increase their size, that the fibres of the leather are torn asunder, and the leather is almost worthless.

Carpets.—Velvet pile and Brussels carpet are both used; the former usually without pattern, and the latter, if it have any pattern at all, should be a small and neat design.

Mr. Farr has drawn attention to the fact that most of the patterns used on carpet and floor-cloth in English carriages are devoid of good taste, and, no doubt, there is room for improvement in this respect.

Floorcloths:—Oilcloth and linoleum are both employed for outside footboards. The same remark as to pattern applies to them as well as carpets, and when they are used they should always be welted.

India-rubber Mats and corrugated and pyramid rubber sheeting.

Laces.—Coach laces are woven in a great variety of qualities, ranging from cotton, with a worsted figure, to an all silk material; but that usually employed in good ordinary work has a silk ground with a worsted figure.

Broad lace is used for borders, falls, glass-strings, pillar hand-holds, etc., the glass-strings being lined with morocco, and the hand-holds with morocco, or silk stuffed with hair.

Seaming lace with two selvages. We place a cord in this lace, and sew the two selvages together over it to give the necessary stiffness to cushion edges, etc.

Binding lace is made of different widths, and may be used for falls and pockets, and for the edges of step-linings.

Pasting lace, for covering edges where there are nail heads, and where other parts of the trimming are joined.

A carriage trimming as supplied complete by the lace-manufacturer, also includes:

Roses through which the top of the swinging holders pass to be fastened to the pillar.

Silk check cord or speaking tube, usually called a "voice conductor."

Silk tassels for blinds.

Silk line for blinds.

Triggers for blinds.

Buttons covered with morocco, or tufts, etc.

A variety of other fabrics are in daily use for lining open carriages, such as those let out on hire or that ply for passengers in the streets of large towns. They include reps, cords, American linen, etc. Such materials as the two former have neither the appearance, nor the durability of cloth. They are too open in texture, and are difficult to stuff to a good shape. American linen for common outside work soon rots, particularly if tufted.

Our list of trimming materials would be incomplete without webbing canvas, black holland, waterproof check, and shalloon.

For stuffing materials we have a number of substances to choose from. Curled hair of best quality is more

elastic and more durable than any other material that has yet been introduced, and, moreover, a properly stuffed cushion can be made with less of it than with hair of a commoner quality. Alva, flock, and other things are employed for stuffing, but not in carriages with any pretensions to excellence. We may include under the head of stuffing materials, spiral steel springs, and cotton wool or wadding, the latter being placed on the top of the hair to give a smooth even finish to the work. Air cushions made with square edges, and covered in the ordinary way, have been tried, but without success. They may be inflated to any degree of hardness, but after an hour or two they become absolutely uneasy to sit upon, instead of affording a perfect rest for the body.

Other things which go to make up the trimming of a carriage are:

Glass-string slides of ivory, or ebony.

Ivory knobs.

Nails with ivory, silver, or brass heads.

Door pulls of ivory or ebony.

Spring barrels and spikes for blinds.

If the brougham which we have been illustrating up to the present has to be trimmed entirely with cloth, we need $8\frac{1}{2}$ to 9 yards. If the back squabs, lower quarters, and one side of cushions are to be of morocco, the lining will take six skins of morocco, and $6\frac{1}{4}$ yards of cloth divided as follows: viz., roof, $1\frac{1}{4}$ yards; glass frames 1 yard; driving-seat with fall, stage, frame and cushion, 2 yards; quarters, $1\frac{1}{4}$ yard; top-back, $\frac{3}{4}$ yard; and cushion bottoms, $\frac{1}{2}$ yard. If the backs and quarters are to be entirely of morocco, the lining will take ten skins and $4\frac{1}{4}$ yards of cloth. As the lining is quilted, four gross of buttons will be required, and the workman will further need 12 yards of broad lace, if there is lace round the roof, half a gross of pasting lace; half a gross of seaming lace; two glass-strings, two glass-string

guards, and two knobs; two hand-holds; $2\frac{1}{2}$ yards lute-string for four blinds; four spring curtain barrels; 16 yards of curtain line; 2 yards velvet-pile carpet; 2 yards carpet binding; 4 tassels; 4 triggers; 6 rosettes; 1 check-cord; 6 yards canvas; $1\frac{1}{2}$ yard black holland; about 40 lb. curled hair, if springs are not used; 2 glass-string slides; 2 door pulls; one dozen ivory nails; about $1\frac{1}{4}$ square foot of border hide for boot-seat valance, and for covering the seat rail, a piece of leather about 8 ft. 3 in. long by $2\frac{1}{2}$ in. wide will be needed.

The sizes of dashers vary so much that the amount of leather can only be approximately stated. It is, however, twice the size of the dasher, with about three-quarters of an inch allowed all round for stitching and dressing off.

If a leather apron is to be used the top will take some 8 to $8\frac{1}{2}$ square feet of No. 2 enamelled leather, and $1\frac{1}{2}$ yard of waterproof check for lining it. The apron checks will each take a piece of enamel measuring approximately 17 in. × 29 in. and lining pieces of black American linen similar in size, while the whole apron will take about $15\frac{1}{2}$ feet of welting. The fall may measure 32 in. × 12 in., but the cloth and laces for it are included in the quantities already given.

For a landau like fig. 23, the trimming materials may be set down as two and a half hides of No. 1 enamelled leather for the head. In common work the head-leather is very often got out of two hides, but in this case no regard is paid to the direction in which the grain of the leather runs. When three hides are used, the spare half can be utilized for an apron.

9 yards of cloth.

8 morocco skins.

8 yards of broad lace.

$\frac{1}{2}$ gross of seaming lace.

$\frac{1}{2}$ gross of pasting lace.

About 40 lb. best curled hair, if springs are not used.
5 yards of canvas.
$2\frac{1}{2}$ yards of black holland.
12 yards of webbing.
2 glass-strings.
2 glass-string slides.
2 glass-string guards.
2 glass-string knobs.
4 hand-holds.
2 yards pile carpet, 27 inches wide.
2 yards carpet binding.
2 door pulls.

The amount of border hide for the driving-seat valance will be about $1\frac{1}{4}$ square foot, while the seat rails will require leather measuring 8 feet 3 in. × $2\frac{1}{2}$ in. if a single rail, or twice that quantity if double.

When the false elbows and rails have been put in by the body-maker, and the head has been set and the webbing nailed on, paper patterns are made for the different pieces of the head leather and for the backs, elbows and cushions. The enamelled hides are cut by those patterns and the foreman who is intrusted with the cutting can, with judgment, effect much economy.

A large hide always cuts to greater advantage than a small one, provided it is fairly square, and if the flank leather happens to be fairly good; and the pieces which are left may sometimes be utilized with little waste in a carriage manufactory in a variety of ways. Large pieces of enamelled hide may be worked up in aprons, etc., while remnants of japanned leather can be used for shaft points, breeching coverings, etc. The trimmer should bear this in mind when he is cutting. The head leather is basted on temporarily for fitting, and when this has been done satisfactorily it is taken off to be sewn and welted. Stitching leather is work that many trimmers do not like, but

leather working is one of the chief branches of their trade, and a trimmer ought to be able to do it as well as any other, especially with the aid of a good welting sewing-machine. Budget trimming, as now understood, is the work of covering dashers, dress-preservers, wings, shaft points, pole-chops, etc., and in some factories it is a distinct branch, *i.e.*, a second department of trimming work. Formerly it was the work of covering the "boots" or "budgets," of travelling carriages and post-chaises. The "budget" or "boot," was generally a strong wooden frame covered with leather, welted round the sides, and was used for carrying trunks and other luggage. Felton said:—"Within these budgets are straps fixed to the bottom, to confine whatever is placed in them, which otherwise would be injured by the motion of the carriage." The covering of wings and dashers demands care and experience, not only in stitching but in straining on the leather. It is an easy matter to spoil a dasher or a wing by making it too damp and stretching it too far; and the result is soon seen in the cracking of the japan after a little use. The work should be basted, the lines carefully marked, and the stitches drawn well down in neat channels cut with the proper tool, so that they do not stand above the surface.

The sewing machine is now much used for this class of work, but we have a preference for hand sewing when leather is the substance to be operated on. For ordinary straight sewing in cloth linings, in pleating, and in falls, glass-strings, etc., the machine produces much better work in every way than can be done by hand; but notwithstanding the marvellous improvements effected in the sewing machine in power and speed, and in working with waxed thread, its work on japanned leather is considered by some to be inferior in regularity or neatness to the even, carefully drawn stitches of hand-sewn work.

The back squab of a landau or brougham is nowa-

days usually laid on a foundation of spiral springs, the number of rows varying according to the custom of the builders. Some use two rows of large springs only, while others use four rows of, say, seven smaller springs.

The back of the body is slightly stuffed and covered with buckram, upon which the rows of springs are sewn. The chief points to be observed are that the springs are placed exactly where they are needed, and that they are properly bridled or tied down to a suitable length and one connected with the other. This must be done securely, so that the working of the spring does not afterwards cause it to become loose. The springs are covered with canvas, and upon this foundation the squab is laid.

The canvas for backs, quarters, and cushions having been cut, the pattern is chalked upon it, and upon the inside of the morocco or cloth. The nap of the cloth should run downward in the back and quarters, and from back to front in the cushions, and the requisite allowance must be made for fulness. This, of course, entirely depends upon the style of the trimming, whether pleated, piped, or quilted, etc. The position of the buttons, or tufts, is marked in the same way, and when the work has been sewn, the squab or cushion is stuffed. The hand is the best stuffing medium, as the trimmer can form a reliable opinion as to the proper quantity of hair, and its even distribution, as he goes on; but it is impossible to get into all little corners with the fingers, and the stuffing-stick becomes necessary, but it should be employed as little as possible.

The cushions partake of the general design of the lining, and may be either spring stuffed, or all hair. The great object to attain is a firm and comfortable seat with a square edge in front, usually 3 inches deep, and a slight inclination to the back. It is advisable that all cushions should be movable, and if spring cushions are used, they are made on a cane or wire framework to which the springs

are fastened. A framed spring cushion of this kind is the most comfortable of all, and retains its shape longer than the ordinary hair cushion. The elbow squabs are marked, cut, stuffed, and tufted like the rest, and nailed to the false elbow-piece, and to the seats. The cloth lining of the head is sewn to listing, which has been nailed to the hoop-sticks of the folding head, which in good work is canvased at the corners, and covered with a piece of thin mackintosh or black duck.

The cloth of the quarters is sewn with seaming lace at the junction of the back and the sides, and this lace is in turn sewn to the outside webbing of the hoop-sticks. The rockers are covered with carpet, and the seats with black linen, and a stuffed roll and fall bordered with lace are nailed on the seat edge.

Doors are now frequently trimmed without pockets or flaps, but whether plain or with pockets or flaps, they offer considerable scope for the young trimmer to show his taste. The squab is usually made on a frame, and the door is marked like the bottom squab, which is to be put on first, followed by the pocket and flap, and bordered with lace. The Institute of British Carriage Manufacturers, with a view to encourage young trimmers to develop a taste for original design, have on several occasions offered prizes for competition. The work has generally taken the form of a trimmed door, and the specimens submitted have shown not only sound workmanship, but the existence of considerable artistic taste on the part of the competitors.

To complete the trimming of the landau, the young workman will have to finish the pillar tops with lace and cord, cover the glass frames with cloth, very evenly pasted and slicked, cover the front light with cloth if it is of wood, and fasten it with webbing to the front rail and hoop-sticks. If a front light with sliding glasses is used, then the head leather is nailed all round the frame in

which the glasses work, and the nails are covered with metal beading. The glass-strings are to be fastened to the frames, and the nails covered with a silver or brass plate screwed on. The head leather has to be carefully pinned down all round, and pared off and the edges dyed black after the metal beading has been fixed. The apron, the stage, and the driving cushion have also to be made, as as well as the fall for the boot seat.

The trimming of a brougham opens out great possibilities for the young workman, but it is surpassed by the trimming of a landau, which offers greater difficulties, and when the trimmer is able to cope with the latter successfully, and to undertake all those pieces of finishing work which impart so much neatness to a carriage, he may congratulate himself on having reached the highest grade of his art.

CARRIAGE FURNITURE.

The beading of carriage bodies is in London a distinct branch of the trade, carried on by specialists, who, by constant practice, attain great skill. Mr. Thrupp has told us that the word "bead" was derived from the pins or nails with large brass heads which in former times were used to hold down the edges of the leather upper quarters and back, but that afterwards, a continuous piece of moulding was used to cover the edge of the leather. In Felton's time the bead was valued according to the width, and was sold by the foot at a price which included the putting on, as is still the case in London.

In the majority of provincial factories at the present day this work is done by the body-maker, or by a workman whose duty principally consists in beading bodies, fitting door-handles, making glass-frames and driving-boxes. The work of beading a brougham or a landau body is not

difficult; but it must be done accurately, and requires practice to acquire the necessary skill in bending the bead to regular curves, so that it may fit close, to prevent water finding admittance at the pin holes. If water gets underneath the leather covering of brougham quarters, a blister rises and ruins the appearance of the carriage; to prevent such an occurrence, a brougham should be beaded before the finishing varnish is put on.

So that it may bend readily, carriage bead is made in the form of a hollow metal moulding filled with a composition, or solder, of lead and tin, which is readily melted, and in which the shanks of the pins are fixed. The thin sheet of metal of which the bead is formed, may be of German silver plated with real silver, or of copper, plated with silver. Speaking generally, both kinds are made in two qualities; best silver on German silver being the kind used in good work. The constant rubbing of the silver when a carriage is being cleaned, soon wears away the plating of the commoner kinds, and leaves the metal exposed. Burnished brass bead is used on many brass-mounted carriages, but much of the beading of bodies is now finished black, and for this purpose the coachmaker employs a brass bead with a roughened surface, which holds the paint. There are few things in which so much deception may be practised as in silver-plating, and as the appearance of a soundly-built and well-finished carriage may soon be spoiled by silver-plated fittings of low quality, such as beading, cornice moulding, lamps, handles, etc., it behoves the coachmaker to obtain such goods from reputable firms. The demand for cheap carriages has led to the introduction of a very "cheap and nasty" class of plated work. As we had occasion to observe at the beginning of this book, the carriage purchaser is seldom a judge of quality, and it is sometimes impossible to convince him that the price of a carriage can be reduced by several pounds

merely by the employment of an inferior quality of plated furniture.

Under this head we include lamps, outside and inside door-handles, brake handles, head finishers, head finishers, head locks, glass-frame fittings, escutcheons, shaft points, tug-plates, staples, hind-door fasteners, rein-rails, etc. In London-made carriages the fixed lamp, *i.e.*, a lamp with a fixed shank bolted to the front pillar, or other part of the body, is much more generally used than in the provinces. In the provinces, movable lamps, fitting into oval tapered sockets, are the rule, and are easily removed for cleaning, or to prevent them being damaged. In some London establishments, the custom is to have the lamps fitted to the carriage by the lamp-maker, before they are either lined or japanned; the finishing is thus completed after the handling by the workman in fitting. When lamp-sockets are made to standard sizes as shown in the appendix, there is no difficulty about the lamps fitting.

Carriage lamps are generally made to burn candles, but some are fitted with oil burners, and if carefully attended to and kept clean, they usually burn well. Inside lamps are not much used except in large vehicles, such as omnibuses. For private carriages, candle lamps should be employed, as oil gives off a disagreeable odour. During recent years some coachmakers have fitted their broughams and private omnibuses with small two or three candle-power dial lamps, worked by a secondary battery which is placed in the boot. This form of lamp is very convenient for medical men, and for those who wish to read while driving at night or on gloomy days.

There are many designs of carriage door-handles, but the plain ruler and the loop shapes are preferred, because they look neat, are easily cleaned, and are more comfortable for the hand when opening and shutting the doors than some of the more elaborate patterns. They ought to

be well plated on German silver, and the spindles should be of the best wrought-iron very carefully fitted.

Brake-handles, rein-rails and shaft tips are usually plated on the iron, and unless the plating is carefully done, it may chip off and leave black marks which are very unsightly. The patent movable handles, being plated on white metal, are free from this defect.

Bead finishers should be well plated with silver, when made to an ornamental pattern, and the edges and corners are soon rubbed through if the metal is badly plated.

Landau head-locks are generally plated on white-metal, and the alloy should be hard enough to prevent them bending under the strain they have to bear when the head is drawn close. Side tug-plates and staples, and hind-door fasteners, are often made of the same metal, but soon show signs of wear. Aluminium is now being tried for such fittings, and, if hardened with antimony, should be satisfactory; but its appearance is not equal to that of silver.

In carriages of the higher class, such accessories as trays with card-cases, writing-cases, cigar-trays, mirrors, perfume-bottles, clock and watch holders, etc., are very often used. As a rule, the fittings are covered with morocco leather that matches the lining of the vehicle. Wealthy people in Paris, New York, Chicago, etc., have those articles got up in a more costly fashion, some in carved ivory or ebony, or with mountings of gold and silver, but buyers of the best English carriages do not care for them.

APPENDIX.

REMARKS ON THE WEIGHT OF CARRIAGES.

By Mr. G. A. Thrupp (May 1878).

Printed by permission of the author.

THERE are very few coachmakers who have not been sorely vexed and tormented with popular opinions on the weight of carriages. The public have a vague idea that the lighter a carriage is, the better for them and for the horse or horses that are to draw the carriage. As however, this idea does not always lead to satisfactory results, it is necessary to draw attention to the actual weight of a vehicle, and the still more important point of the weight of the persons carried in and on the vehicle. Owners of carriages seem to be hardly aware that the *total* weight behind the horses depends so greatly upon the number of people that are carried. The following calculations suppose a low average weight for adults of 10 stone each, that is 140 lb., equal to $1\frac{1}{4}$ cwt. The omnibuses that ply in London, according to the report of the London General Omnibus Company, weigh each 24 cwt. If we add twelve inside and sixteen outside passengers at 10 stone each, we arrive at a total weight for passengers of 35 cwt., and, adding the weight of the omnibus, it appears that two horses actually draw 59 cwt. which is nearly 3 tons. This load is obviously an unreasonable load, and we are not surprised to find that the horses of the Omnibus Company rarely last more than five years at such hard work. If we take the case of a chariot, or large barouche, or landau upon C springs,

the average weight of which may be 18 cwt., and add the weight of six adults, $7\frac{1}{2}$ cwt. more, we arrive at $25\frac{1}{2}$ cwt., or only $12\frac{3}{4}$ for each horse's share of the total load, instead of $29\frac{1}{2}$ to each omnibus horse. A coach such as was common at the commencement of Queen Victoria's reign, and such as still are occasionally used by the nobility and gentry during the London season, with four inside, and coachman and two tall footmen, weighs with its load but 30 cwt., a ton and a half, only 15 cwt. to each horse, half the weight that each omnibus horse draws. But consider the work which is expected from "One" livery stable-horse. The double brougham or landau, weighing rarely less than 10 cwt., and often 11 cwt., when loaded with four adults weighs altogether 15 cwt., and with six adults may weigh $18\frac{1}{2}$ cwt. If one horse can draw easily 15 cwt. for a livery stable keeper, and even $18\frac{1}{2}$ cwt. to the theatre and evening parties, surely two horses are not overloaded with 30 cwt. behind them in a coach.

The landau carriages plying for hire at Brighton and Hastings are smaller, and consequently lighter, than those chiefly used in London; yet none of these weigh less than 8 cwt. and most of them weigh 10 cwt., and with four adults at 5 cwt., or six at $7\frac{1}{2}$ cwt., give to be drawn by one horse 13 cwt to $15\frac{1}{2}$ cwt. Now, a landau such as private gentlemen use, hung upon elliptic springs, weighs from 11 to 14 cwt., the average weight may be called $12\frac{1}{2}$ cwt., and with six persons reaches a total of 1 ton, or 10 cwt. to each horse of a pair. The smallest single broughams rarely weigh so little as 7 cwt., and with only a coachman and two inside must weigh $10\frac{1}{2}$ cwt. The larger single broughams, rarely less than 10 cwt., with two inside and a coachman and footman reach 15 cwt.

How few persons who pass opinions upon the weights of carriages remember this! How common it is to hear gentlemen and coachmen speak of a *landau* as a *heavy*

carriage for two horses, and a *brougham* as a *light* carriage for one horse! We see, however, that under no circumstances will a brougham weigh only half the landau, whilst it frequently is three-quarters of the weight of a landau. If a landau, then, requires a pair of horses, a brougham ought to have a horse and a pony attached to make the comparison just. We shall be content, however, if those who ride in one-horse broughams will allow that two horses have an easy time of it in a landau. A victoria with three or four persons is also an easy load for one horse.

Country coachmakers have often observed that gentlemen, who are very apt to listen to complaints by their coachmen of the weight of carriages on country roads, seem to consider the powers of the fly horses at railway stations as being of a very superior order to that of their own horses. A railway fly horse will draw his vehicle with the driver and four inside, and a lot of luggage on the roof—often a ton altogether—for a ten mile stage in an hour and a half, and this without being distressed. These horses work very much harder than a carriage horse, and yet many have been on the road from ten to fifteen years. It is of importance also to consider the great advantage of a well-hung and balanced carriage; the universal testimony of coach-builders is that such a carriage follows the horse better than a clumsy ill-balanced carriage: nor is it necessary to have the wheels very close together. The advantage in waggonettes and such like carriages, is that the chief part of the weight is carried by the *higher* wheels. Many of the large omnibuses would be at once made to follow the horses more easily if the front wheels were *further* from the hind wheels and more under the driver's seat. In the tables that follow, the weight of a drag is set down at an extreme weight, but although small drags have been made to weigh only 17 to 18 cwt., if the front wheels are low and set too far back, they will distress their team as much as a

larger drag, and throw an unfair stress upon the pole in going down hill. It cannot be too often repeated that the draught of a carriage depends on the actual weight of the carriage, and its proper bearing upon the front and hind wheels, and not so much upon the distance apart of the front and hind wheels. It should be remembered also, that a very light carriage is often unsteady in its motion, and always more noisy, just as a tin kettle will make more noise than an iron one if dragged along a road quickly; also that the introduction of tramways has shown us how easily a light wheel may be wrenched from a carriage, or the carriage altogether wrecked by the projecting rails and cast-iron grooves. I have been asked to state that most of the General Omnibus Company's horses are animals of great power and weight, and are capable of doing more than the ordinary carriage horse, and that the introduction of brakes to help to stop the 'bus, has contributed very much to lengthen the ordinary life of the omnibus horse. In conclusion, I hope that the few remarks I have made may help to rouse public attention to the fair work that a horse can do, as well as the care that coachmakers generally take that the carriages they build shall be as light as is consistent with the strength required, and the comfort and well-being of those who occupy the seats of English pleasure carriages.

These remarks are assented to by:—Thrupp and Maberly, Hooper and Co., W. and T. Thorn, R. Shanks and Co., Hall and Sons, Ivall and Large, of London, H. and A. Holmes, Derby, Rock and Hawkins, Hastings, T. R. Starey, Nottingham, H. Kinder, Leicester, Joseph Cockshoot and Co., Manchester.

TABLE OF WEIGHTS.

VEHICLE.	Weight in cwts.	With 6 Persons added.	Weight behind each Horse.	With 12 Persons.	Weight behind each Horse.	With 18 Persons.	Weight behind each Horse.
FOUR HORSE.							
Drag coach	22	29½	7½	37	9¼	44½	11
		With 12 Persons.		With 18 Persons.		With 28 Persons.	
PAIR HORSE.							
Street omnibus	24	39	19½	46½	23¼	59	29½
		With 6 Persons.		With 10 Persons.		With 14 Persons.	
Private omnibus	14½	22	11	27	13½	32	16
		With 2 Persons.		With 4 Persons.		With 6 Persons.	
PAIR HORSE.							
C-spring landau	17	19½	9¾	22	11	24½	12¼
C-spring barouche	14½	17	8½	19½	9¾	22	11
Elliptic landau	13	15½	7¾	18	9	20½	10¼
Small landau	11	13½	6¾	16	8	18½	9¼
Clarence brougham	12	14½	7¼	17	8½	19½	9¾
Large single brougham ...	10½	13	6½	15½	7¾	—	—
Bow front brougham	10½	13	6½	15½	7¾	18	9
Large waggonette	9½	12	6	14½	7¼	17	8½

VEHICLE.	Weight in cwts.	With 2 Persons added.	Weight behind each Horse.	With 4 Persons.	Weight behind each Horse.	With 6 Persons.	Weight behind each Horse.
ONE HORSE.							
Landau	11	13½	13½	16	16	18½	18½
Very small landau	9	11½	11½	14	14	16½	16½
Bow brougham	10½	13	13	15½	15½	18	18
Miniature brougham	8½	11	11	13½	13½	16	16
Large single brougham ...	10	12½	12½	15	15	—	—
Very small brougham	7	9½	9½	12	12	—	—
Small waggonette	8	10½	10½	13	13	15½	15½
Victoria	7	9½	9½	12	12	—	—
Phaeton T. cart...	6	8½	8½	11	11	—	—
Pony Phaeton	5	7½	7½	With 3 Persons, or 2 Adults and 2 Children.		8¾	8¾
Basket Phaeton...	4	6½	6½			7¾	7¾

NOTE BY MR. THRUPP, SEPTEMBER 13TH, 1896.

In treating of the height of wheels and the distance at which they should be placed from each other, our old rules and ideas must be modified,

1st. By the smooth roads now so general, especially in cities;

2nd. By the speed of travelling;

3rd. By our experience of tramways, bicycles, tricycles, etc.; and

4th. By whether the vehicle is *drawn* by horses or a locomotive, or is *propelled*.

In the latter case, I am inclined to believe much greater strain is thrown upon the front springs and front wheels, necessitating, perhaps, a greater distance between the front and hind wheels as the hind wheels become the driving wheels. Also, the track, I think, will have to be kept wide to avoid overturns when the front wheels meet with obstacles over which a *horse-drawn* vehicle would more easily mount.

INSTITUTE OF BRITISH CARRIAGE MANUFACTURERS (INCORPORATED), TOWN HALL, WESTMINSTER, LONDON, S.W.

STANDARD SIZES OF AXLES (COLLINGE'S PATENT),

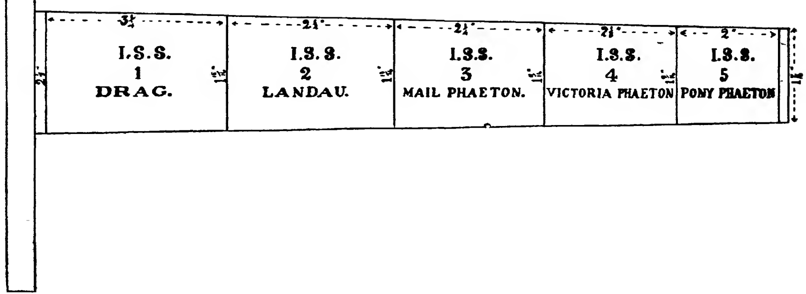
AS SETTLED BY THE COUNCIL FOR STANDARD SIZES. *(Reprinted by permission of the Council.)*

Reputed size of axle	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	inches.
Size of arm	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$	,,
Size of bed	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	,,
Diameter of cone of shoulder...	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	$2\frac{1}{16}$	$2\frac{1}{16}$	$2\frac{5}{16}$	$2\frac{7}{16}$	,,
Length of ditto	20	22	24	26	28	30	32	34	36	32nds of an inch.
Diameter of collett bearing	28	31	34	38	42	45	48	51	54	,, ,,
Do. first screw...	25	28	31	34	37	40	43	46	49	,, ,,
Do. second screw	20	22	24	26	29	32	35	38	41	,, ,,
Length of collett bearing	20	22	24	26	28	28	28	30	30	,, ,,
Do. first screw ...	22	24	26	28	30	32	34	36	36	,, ,,
Do. second screw	14	16	16	18	20	20	22	24	24	,, ,,
Pitch of thread, first screw	10	9	9	9	8	8	8	8	8	threads to the inch (Whitworth).
Do. second screw...	13	12	12	12	11	11	9	9	9	,, ,, ,,
Size over flat of collett bearing	$\frac{4}{32}$nds of an inch less than diameter.									
Diameter over collar of collett	$\frac{1}{32}$nd ,, ,, inside screw of box.									
Do. do. nuts	$\frac{1}{32}$nd ,, more than over the square of angle of nuts.									
Size over square of nuts	32	35	39	42	46	49	53	56	60	32nds of an inch.
Length of box	$7\frac{1}{2}$	8	$8\frac{1}{2}$	9	$9\frac{1}{2}$	10	$10\frac{1}{2}$	11	$11\frac{1}{2}$	inches.
Diameter over head of box	$2\frac{10}{16}$	$2\frac{14}{16}$	$3\frac{2}{16}$	$3\frac{5}{16}$	$3\frac{9}{16}$	$3\frac{12}{16}$	$3\frac{15}{16}$	$4\frac{3}{16}$	$4\frac{6}{16}$	,,
Depth of head of box ...	10	10	10	10	12	12	12	12	12	32nds of an inch.
Diameter over collar washer	$2\frac{4}{16}$	$2\frac{8}{16}$	$2\frac{12}{16}$	$2\frac{15}{16}$	$3\frac{3}{16}$	$3\frac{6}{16}$	$3\frac{9}{16}$	$4\frac{11}{16}$	$4\frac{10}{16}$	inches.
Do. inside screw box	46	50	55	60	65	70	75	80	85	32nds of an inch.
Depth of screw in box ...	22	24	26	26	28	28	30	32	32	,, ,,
Pitch of thread in box...	14	14	14	14	12	12	12	12	12	threads to the inch (Whitworth.)
Size of cap over square	64	68	72	76	80	84	88	92	96	32nds of an inch.
Cone or bevel on collett	at an angle of 45 degrees.									

INSTITUTE OF BRITISH CARRIAGE MANUFACTURERS
(INCORPORATED).

DIMENSIONS OF MANDRELS FOR CARRIAGE LAMP-SOCKETS,
AS SETTLED BY THE COUNCIL FOR STANDARD SIZES.

Reprinted by permission of the Council.



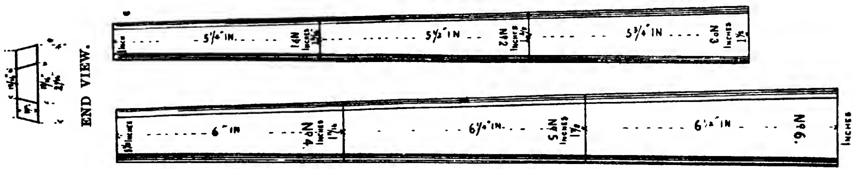
Institute of British Carriage Manufacturers (Incorporated).

DIMENSIONS OF MANDRELS FOR PANS OF CARRIAGE BRAKE-BLOCKS,

As Settled by the Council for Standard Sizes, 1888. Mark as on axles I S.S.

Reprinted by permission of the Council.

No. 1.	$1\frac{3}{16}$ in. wide at wide end,	1 in	wide at narrow end ×	$5\frac{1}{4}$ in. long.
No. 2.	$1\frac{3}{8}$,, ,, ,,	$1\frac{1}{16}$	,, ,, ,,	$5\frac{1}{2}$,,
No. 3.	$1\frac{1}{2}$,, ,, ,,	$1\frac{1}{4}$	,, ,, ,,	$5\frac{3}{4}$,,
No. 4.	$1\frac{11}{16}$,, ,, ,,	$1\frac{1}{2}$	,, ,, ,,	× $6\frac{1}{4}$,,
No. 5.	$1\frac{7}{8}$,, ,, ,,	$1\frac{11}{16}$	,, ,, ,,	× $6\frac{1}{4}$,,
No. 6.	$2\frac{1}{16}$,, ,, ,,	$1\frac{7}{8}$	,, ,, ,,	× $6\frac{1}{2}$,,



STANDARD SIZES.

It will be seen that the Institute of British Carriage Manufacturers has formulated tables of standard dimensions for carriage-axles, shafts, lamp-sockets, and brake-blocks, and, in like manner, a qualified and representative committee might deal with the proportions of carriage-poles, splinter-bars and splintrees, as well as the dimensions of the screws and nuts of coach-bolts and clips. There must, however, be a limit to standard sizes in the case of private carriages. Carriages are not made by the gross, to a certain pattern, like bicycles. The builders of vehicles of the best class seldom make two alike in every detail, and it is probable that, with the exception of such standard dimensions as we have indicated, they would decline to accept arbitrary measurements for other parts of their work, such as the wheels and springs.

The principal advantage to be gained by an adoption of standard sizes, is economy to the manufacturer by reason of the lessened cost of producing articles in numbers at one time; while the carriage-user profits by the facility with which repairs, exchanges and renewals can be made. Thus the chief gainers by such a system are large public companies, and those who use a number of vehicles identical in shape and size. The London General Omnibus Company, the Metropolitan Police, the Road Car Company, the London Improved Cab Company, and other bodies, have adopted standard dimensions, because a vehicle can be kept running by the ready substitution of a wheel, axle, spring, shaft, or other part, when a breakdown occurs, instead of having to stand idle for repairs which may

occupy days or weeks, while another carriage takes its place on the road. In the case of omnibus and carriage companies, profit or loss entirely depends upon the continuous working of the vehicle.

Since the use of solid rubber and pneumatic tyres became more general, many people have two sets of wheels for their carriages; one set with rubber or pneumatic tyres, and the other with ordinary iron tyres: the former for use in fine weather, and the latter for the winter or when the roads are bad. This merely entails having the axle-boxes of the same dimensions, and if the coachmaker works to standard sizes he has no difficulty whatever in supplying such wheels.

J. P.

REQUIREMENTS FOR THE FOREIGN AND COLONIAL TRADE.

Compiled from information obtained by the Institute of British Carriage Manufacturers, during the presidency of Mr. G. N. Hooper, in response to applications made to British Consuls and Colonial Agents. Printed by permission of the Council.

Aleppo (Turkey).—Strong, light, four-wheeled carriages at moderate prices preferred, for two horses, about 14 h. h. Climate excessively hot in summer, cold in winter. Roads level, but soft and muddy in winter.

Andalusia (Spain).—Strong four-wheeled carriages. Three-quarter lock necessary. Two horses or mules, averaging 15 h. h. Roads and streets badly kept; track, 56 to 60 in. Very hot in summer, very wet in winter. Quiet colours preferred.

Akyab (Province Aracan, Burmah).—Light, strong, cheap carriages. Four-wheeled gharries and two-wheeled dog-carts. Two ponies generally used for four-wheelers. Close carriages to have louvres back and front, and sliding doors. Roads level and good; track about 4 ft. Climate temperate. Excessively wet for six months.

Arica and Tacna (Peru).—Four-wheeled, low-priced, full lock carriages for two horses. Climate very fine and dry. Roads bad and hard. Brakes unnecessary.

Austria.—Importation scarcely possible. Home-made broughams and victorias are sold at £50 to £60. Low-priced, light, full lock carriages, for horses 15 to 15.3 h. h. High-roads good; local roads less so. Cold winter, hot summer, windy and dusty.

Bangkok (Siam).—Low price chief requisite. Moderately light open carriages, for one or two ponies, 11 to 12 h. h. Brake or full lock unnecessary. Roads level and fairly good. Climate hot. Cloth soon destroyed by moths.

Bareilly (N.-W. Province of India).—Low-priced, light carriages, for use with one or two small horses 14 to 15 h. h. Full lock and brake not necessary. Cart track 4 ft. 3 in. between wheels. English linings. Climate alternately dry and very wet; trying to wood and leather.

Bosnia and Herzegovina (Austria).—Second-hand Austrian carriages principally used. Strength, lightness, cheapness necessary. Full lock and brakes. Gay colours. Horses 15 h. h., ponies 13·2 h. h. Driven with loose splinter-bars and breast-straps. Track 3 ft. 6 in. Roads hilly, muddy, and bad. Summer warm; winter very cold, with much snow.

Buenos Aires (Argentine Republic).—Strong, light, showy carriages preferred. Horses 14·2 to 15 h. h., driven as in England. Track 4 ft. 8½ in. Brakes unnecessary. Roads, as understood in England, not known outside of city; town streets bad.

Bulgaria.—English and American carriages unknown. All carriages on four wheels. Low price most essential. Horses 14 to 14·2 h. h. Small and light. Track 3 ft. 7 in. to 3 ft. 11 in. Town streets bad; country roads fairly good. Climate severe; very hot and very cold. Painting very light or very dark, with gilded lines. Trimming, dark cloth or leather.

Caracas (Venezuela). Strong carriages, for two small horses. Low price not essential. Full lock and brakes necessary. Climate hot, wet, and dry. Roads hilly, soft, and bad. Prevailing styles: Caleches and landaus. Colours quiet. Cloth and leather.

Cherbourg (France). Light, low-priced carriages, with full lock and brake. Used as in England and France. Horses 14 to 15 h. h. Country hilly, roads good.

Constantinople (district).—English carriages preferred. Mostly four-wheeled. Full lock and brakes needed. Roads very rough. Russian horses 16 h. h.; Hungarian, 15 h. h.; Native, 14 h. h. and under. Broughams, landaus, and victorias. Lightness, good finish, and cheapness essential.

Dutch Guiana.—American carriages preferred. Four wheels mostly used. Buggy lock sufficient. Brakes unnecessary. Low price. Roads indifferent, level, sandy; track, 4 ft. 6 in. Imported horses 15 to 17 h. h.; natives only pony size.

East Prussia.—English type preferred. Mostly closed. Full lock, brake, and low price essential. Two horses, 15 to 15·2 h. h., generally harnessed as in England. Roads good; track, 4 ft. 4 in.

Frankfort-on-Main (Germany).—English and French type preferred. Mostly four wheels. Light and strong. Full lock and brake. One or two horses, harnessed as in England. Horses 16 to 16·2 h. h. Quiet dark colours. Roads hilly, but good.

Gallipoli (Italy).—English type preferred. Mostly four-wheeled.

Two and three horses, harnessed as in England. Roads hilly, good, uniform, rather soft; track, 5 ft.

Gothenburg (Sweden).—English carriages preferred, but too expensive; Danish mostly used. High quality and finish; lightness; four wheels; two horses, 15 h. h. Broughams in winter landaus in summer. Roads hilly, hard, good; track, 5 ft. 4 in. Brakes would be useful.

New Orleans (U.S.A.).—Practically no carriages imported from Europe. English patterns preferred for ladies, American for men. Mostly four wheels. Low price, very light. Horses 14 to 15 h. h., harnessed as in England. Roads dead flat, bad, and soft; various tracks. Climate hot.

Palermo (Sicily).—Carriages chiefly made in Milan and other parts of Italy. Low price, good quality. Four wheels. One or two horses, 14 to 15 h. h. Brakes not used. Roads good.

Puerto Rico (New Granada).—American carriages almost invariably used. Light, and low priced. Open, with leather hood. One or two ponies, 13 to 15 h. h. Track 4 ft., 4 ft. 6 in. to 5 ft. Main roads fairly good, country roads hilly and bad. No brakes, but breeching straps necessary.

La Rochelle, district (France).—English and American carriages scarcely known. Light, low-priced vehicles. Mostly four-wheeled, with full lock. Generally made in the country; good ones from Paris. Horses 15 to 16 h. h., harnessed as in England. Level roads, soft and muddy, often bad; track similar to English.

Roumania.—Austrian carriages preferred. Very few two-wheelers. Low price, lightness, and strength essential. Horses 15 h. h., driven as in England. Private carriages mostly made to open and close. Roads level, but bad as a rule; hard in winter, very soft in summer. Climate dry; extreme heat and cold. Quiet colours, preferably black. Cloth and fine morocco.

Rome (Italy).—English type preferred. Lightness, four wheels, good quality; for one or two horses, 15 to 16·2 h. h. Carriages with brakes; mostly open. Track similar to English. Quiet colours; silk, cloth, or leather.

Saigon (Cochin-China).—Lightness and low price essential. Mostly open, four-wheeled vehicles, for two ponies of ordinary size harness, with neck collars. Roads level, hard, very good. Climate hot; partly wet and dry. Quiet colours; cloth and leather.

Salonica and Macedonia (generally).—Nearly all carriages im-

ported from Austria and France; English and American unknown. Full lock, with front wheels to go under body. Low price essential. Mostly four-wheelers, for two small horses, 14 to 15 h. h. Some carriages closed, others half open; none completely open. All kinds of colours and linings. Temperate summers, wet winters. Track similar to England. Roads both level and hilly; some hard, others soft and muddy, some good and some bad.

St. Domingo (Dominican Republic).—American carriages preferred. Low prices and lightness. Mostly open, for one or two ponies, driven as in England. Large track, high wheels. Climate very hot and wet. Roads very bad, soft, and muddy. Quiet colours; leather linings.

Sardinia (Italy).—English type preferred. Full lock unnecessary. High quality or finish would not attract purchasers; low price and strength might secure business. Mostly four-wheeled vehicles, for two cobs 14 h. h. Carriages usually closed or semi-closed. Brakes on all four-wheeled carriages. Track 4 ft. 6 in Roads generally good. Climate temperate and dry. Quiet colours; cloth.

St. Petersburg (Russia).—English type preferred. Full lock necessary. Low price, good workmanship, and great strength. Medium lightness. Mostly four-wheeled open carriages, for two horses, 15 to 16 h. h. Landaus in summer. Brakes unnecessary. Track 5 ft. Roads level, but badly paved with cobble stones. Hot summer, cold winter. Quiet colours; silk, leather, and cloth.

Taganrog (South Russia).—English and American carriages unknown. Four-wheeled carriages (droskies) in use, for one, two, or three horses, 15·2 h. h. Low price essential. Any other track than 3 ft. 6 in. would be useless. Brakes seldom used, as the country is flat. Climate: extremes of heat and cold; dry. Both gay and quiet colours. Leather lining most practical, on account of the dust.

Tehran (Persia).—English carriages preferred, but Russian used on account of their cheapness and great strength. American lock impossible, owing to narrow roads; ordinary English lock sufficient. Moderate prices and solid workmanship; springs to be 20 or 25 per cent. stronger than English, on account of bad roads. Four wheels, two and four horses, 14·1 to 15·1 h. h. Both open and closed. Large victorias with cricket or occasional seat preferred. Roads very bad; dry in summer, muddy and heavy

in winter. Climate: hot summer, cold winter; very dry, causing unseasoned woodwork to fall to pieces. Brakes not necessary. Gaudy linings, on account of Russian taste; cloth, silk, and satin general; leather linings uncommon.

Tunis.—English type preferred. Full lock universal. Low price essential. Mostly four-wheeled open carriages, for two horses, 14·2 to 15 h. h. Vehicles strong and light as possible. Brakes unnecessary. Track 3 ft. 6 in. Roads flat, macadam in neighbourhood of town; roads outside soft and muddy in winter. Hilly in some places. Linings of gaudy red or yellow silk for Arabs; quiet colours for Europeans; landaus, broughams, and victorias for private use. Hot and dry summer; temperate, and often wet in winter.

Wellington (New Zealand). English carriages preferred, but American buggies also. Full lock; strong, good quality, but not elaborate finish. Mostly four-wheeled carriages, both open and closed. Average-sized horses, as in England. Track similar to English. Brakes necessary. Climate temperate, inclined to be wet. Quiet colours; cloth and leather.

Yokohama.—Low price, strength, and lightness essential. Four-wheeled carriages, mostly open, for ponies 12·2 h. h., driven as in England. Broughams, landaus, phaetons, and dog-carts all used, but no particular type prevails. Good deal of flat road. Climate: cold January to March, then pleasant warm spring; hot July to September, then very bright to end of year, when cold increases.

NOTE.—Places such as Philadelphia (U.S.A.) and New Caledonia are not enumerated in this list, although given in the Institute tables. In such cases importation is practically impossible. Nothing but American carriages are used, or are likely to be used, in Philadelphia and other American cities. In the case of New Caledonia, there are only thirty miles of road in the island, and the natives are cannibal savages.

Everyday experience shows me that there is a demand for carriages in various parts of India, South Africa, West Indies, Mexico, Chili, Peru, and Bolivia; but it is also evident that the cost of high-class English carriages is more than buyers in those countries will incur. The trade is consequently falling chiefly into the hands of American manufacturers, who produce light, cheap vehicles, which, although lacking the solidity and durability of English work, meet the wishes of buyers in the matter of price.—J. P.

TEXT BOOKS ON CARRIAGE BUILDING.

"History of Coachbuilding," by G. A. Thrupp. Kerby and Endean, London. 10*s*. 6*d*.

"Coach Body-making," by John Philipson. John Kemp and Co., London. 4*s*.

"Harness," by John Philipson. E. Stanford, London. 5*s*.

"Draught," by Wm. Philipson. John Kemp and Co., London. 2*s*. 6*d*.

"Suspension of Carriages," by Wm. Philipson. E. and F. N. Spon, London. 5*s*.

"Underworks of Carriages," by G. F. Budd. John Kemp and Co., London. 2*s*. 6*d*.

"Smithy and Forge," by W. J. E. Crane. Crosby, Lockwood and Co., London. 2*s*. 6*d*.

"Manufacture of Carriage Springs," by John S. Foggett. John Kemp and Co. 2*s*. 6*d*.

"Manufacture of Carriage Wheels," by John S. Foggett. John Kemp and Co. 2*s*. 6*d*.

"Coachmakers' Timber," by John S. Foggett. John Kemp and Co. 6*d*.

"Handbook for Coach-painters," by Simpson and Thrupp. J. and C. Cooper, London. 1*s*.

"Handbook for Trimmers," by Farr and Thrupp. Chapman and Hall, London. 2*s*. 6*d*.

"Coach-painters' Guide," by A. Boag. P. J. Jackson, Newcastle. 12*s*. 6*d*.

INDEX.

CHISWICK PRESS:—CHARLES WHITTINGHAM AND CO.
TOOKS COURT, CHANCERY LANE, LONDON.

AN

ALPHABETICAL LIST

OF BOOKS CONTAINED IN

BOHN'S LIBRARIES.

Detailed Catalogue, arranged according to the various Libraries, will be sent on application.

ADDISON'S Works. With the Notes of Bishop Hurd, Portrait, and 8 Plates of Medals and Coins. Edited by H. G. Bohn. 6 vols. 3*s*. 6*d*. each.

ÆSCHYLUS, The Dramas of. Translated into English Verse by Anna Swanwick. 4th Edition, revised. 5*s*.

—— **The Tragedies of.** Translated into Prose by T. A. Buckley, B.A. 3*s*. 6*d*.

AGASSIZ and GOULD'S Outline of Comparative Physiology. Enlarged by Dr. Wright. With 390 Woodcuts. 5*s*.

ALFIERI'S Tragedies. Translated into English Verse by Edgar A. Bowring, C.B. 2 vols. 3*s*. 6*d*. each.

ALLEN'S (Joseph, R. N.) Battles of the British Navy. Revised Edition, with 57 Steel Engravings. 2 vols. 5*s*. each.

AMMIANUS MARCELLINUS. History of Rome during the Reigns of Constantius, Julian, Jovianus, Valentinian, and Valens. Translated by Prof. C. D. Yonge, M.A. 7*s*. 6*d*.

ANDERSEN'S Danish Legends and Fairy Tales. Translated by Caroline Peachey. With 120 Wood Engravings. 5*s*.

ANTONINUS (M. Aurelius), The Thoughts of. Trans. literally, with Notes and Introduction by George Long, M.A. 3*s*. 6*d*.

APOLLONIUS RHODIUS. 'The Argonautica.' Translated by E. P. Coleridge, B.A.

APPIAN'S Roman History. Translated by Horace White, M.A., LL.D. With Maps and Illustrations. 2 vols. 6*s*. each.

APULEIUS, The Works of. Comprising the Golden Ass, God of Socrates, Florida, and Discourse of Magic. 5*s*.

ARIOSTO'S Orlando Furioso. Translated into English Verse by W. S. Rose. With Portrait, and 24 Steel Engravings. 2 vols. 5*s*. each

ARISTOPHANES' Comedies. Translated by W. J. Hickie. 2 vols. 5*s*. each.

BRIDGEWATER TREATISES *continued.*

Kidd on the Adaptation of External Nature to the Physical Condition of Man. 3*s.* 6*d.*

Chalmers on the Adaptation of External Nature to the Moral and Intellectual Constitution of Man. 5*s.*

BRINK (B. ten) Early English Literature. By Bernhard ten Brink. Vol. I. To Wyclif. Translated by Horace M. Kennedy. 3*s.* 6*d.*

Vol. II. Wyclif, Chaucer, Earliest Drama Renaissance. Translated by W. Clarke Robinson, Ph.D. 3*s.* 6*d.*

Vol. III. From the Fourteenth Century to the Death of Surrey. Edited by Dr. Alois Brandl. Trans. by L. Dora Schmitz. 3*s.* 6*d.*

—— **Five Lectures on Shakespeare.** Trans. by Julia Franklin. 3*s.* 6*d.*

BROWNE'S (Sir Thomas) Works Edited by Simon Wilkin. 3 vols. 3*s.* 6*d.* each.

BURKE'S Works. 8 vols. 3*s.* 6*d.* each.

I.—Vindication of Natural Society—Essay on the Sublime and Beautiful, and various Political Miscellanies.

II.—Reflections on the French Revolution — Letters relating to the Bristol Election — Speech on Fox's East India Bill, &c.

III.—Appeal from the New to the Old Whigs—On the Nabob of Arcot's Debts—The Catholic Claims, &c.

BURKE'S WORKS *continued.*

IV.—Report on the Affairs of India, and Articles of Charge against Warren Hastings.

V.—Conclusion of the Articles of Charge against Warren Hastings—Political Letters on the American War, on a Regicide Peace, to the Empress of Russia.

VI.—Miscellaneous Speeches—Letters and Fragments—Abridgments of English History, &c. With a General Index.

VII. & VIII.—Speeches on the Impeachment of Warren Hastings; and Letters. With Index. 2 vols. 3*s.* 6*d.* each.

—— **Life.** By Sir J. Prior. 3*s.* 6*d.*

BURNEY'S Evelina. By Frances Burney (Mme. D'Arblay). With an Introduction and Notes by A. R. Ellis. 3*s.* 6*d.*

—— **Cecilia.** With an Introduction and Notes by A. R. Ellis. 2 vols. 3*s.* 6*d.* each.

BURN (R.) Ancient Rome and its Neighbourhood. An Illustrated Handbook to the Ruins in the City and the Campagna, for the use of Travellers. By Robert Burn, M.A. With numerous Illustrations, Maps, and Plans. 7*s.* 6*d.*

BURNS (Robert), Life of. By J. G. Lockhart, D.C.L. A new and enlarged Edition. Revised by William Scott Douglas. 3*s.* 6*d.*

BURTON'S (Robert) Anatomy of Melancholy. Edited by the Rev. A. R. Shilleto, M.A. With Introduction by A. H. Bullen, and full Index. 3 vols. 3*s.* 6*d.* each.

BURTON (Sir R. F.) Personal Narrative of a Pilgrimage to Al-Madinah and Meccah. By Captain Sir Richard F. Burton, K.C.M.G. With an Introduction by Stanley Lane-Poole, and all the original Illustrations. 2 vols. 3*s.* 6*d.* each.

*** This is the copyright edition, containing the author's latest notes.

BUTLER'S (Bishop) Analogy of Religion, Natural and Revealed, to the Constitution and Course of Nature; together with two Dissertations on Personal Identity and on the Nature of Virtue, and Fifteen Sermons. 3*s.* 6*d.*

BUTLER'S (Samuel) Hudibras. With Variorum Notes, a Biography, Portrait, and 28 Illustrations. 5*s.*

—— or, further Illustrated with 60 Outline Portraits. 2 vols. 5*s.* each.

CÆSAR. Commentaries on the Gallic and Civil Wars, Translated by W. A. McDevitte, B.A. 5*s.*

CAMOENS' Lusiad; or, the Discovery of India. An Epic Poem. Translated by W. J. Mickle. 5th Edition, revised by E. R. Hodges, M.C.P. 3*s.* 6*d.*

CARAFAS (The) of Maddaloni. Naples under Spanish Dominion. Translated from the German of Alfred de Reumont. 3*s.* 6*d.*

CARLYLE'S Sartor Resartus. With 75 Illustrations by Edmund J. Sullivan. 5*s.*

CARPENTER'S (Dr. W. B.) Zoology. Revised Edition, by W. S. Dallas, F.L.S. With very numerous Woodcuts. Vol. I. 6*s.* [*Vol. II. out of print.*

CARPENTER'S Mechanical Philosophy, Astronomy, and Horology. 181 Woodcuts. 5*s.*

—— **Vegetable Physiology and Systematic Botany.** Revised Edition, by E. Lankester, M.D., &c. With very numerous Woodcuts. 6*s.*

—— **Animal Physiology.** Revised Edition. With upwards of 300 Woodcuts. 6*s.*

CASTLE (E.) Schools and Masters of Fence, from the Middle Ages to the End of the Eighteenth Century. By Egerton Castle, M.A., F.S.A. With a Complete Bibliography. Illustrated with 140 Reproductions of Old Engravings and 6 Plates of Swords, showing 114 Examples. 6*s.*

CATTERMOLE'S Evenings at Haddon Hall. With 24 Engravings on Steel from designs by Cattermole, the Letterpress by the Baroness de Carabella. 5*s.*

CATULLUS, Tibullus, and the Vigil of Venus. A Literal Prose Translation. 5*s.*

CELLINI (Benvenuto). Memoirs of, written by Himself. Translated by Thomas Roscoe. 3*s.* 6*d.*

CERVANTES' Don Quixote de la Mancha. Motteaux's Translation revised. 2 vols. 3*s.* 6*d.* each.

—— **Galatea.** A Pastoral Romance. Translated by G. W. J. Gyll. 3*s.* 6*d.*

—— **Exemplary Novels.** Translated by Walter K. Kelly. 3*s.* 6*d.*

CHAUCER'S Poetical Works. Edited by Robert Bell. Revised Edition, with a Preliminary Essay by Prof. W. W. Skeat, M.A. 4 vols. 3*s.* 6*d.* each.

CHESS CONGRESS of 1862. A Collection of the Games played. Edited by J. Löwenthal. 5*s*.

CHEVREUL on Colour. Translated from the French by Charles Martel. Third Edition, with Plates, 5*s*.; or with an additional series of 16 Plates in Colours, 7*s*. 6*d*.

CHILLINGWORTH'S Religion of Protestants. A Safe Way to Salvation. 3*s*. 6*d*.

CHINA, Pictorial, Descriptive, and Historical. With Map and nearly 100 Illustrations. 5*s*.

CHRONICLES OF THE CRUSADES. Contemporary Narratives of the Crusade of Richard Cœur de Lion, by Richard of Devizes and Geoffrey de Vinsauf; and of the Crusade at St. Louis, by Lord John de Joinville. 5*s*.

CICERO'S Orations. Translated by Prof. C. D. Yonge, M.A. 4 vols. 5*s*. each.

—— **Letters.** Translated by Evelyn S. Shuckburgh. 4 vols. 5*s*. each.

—— **On Oratory and Orators.** With Letters to Quintus and Brutus. Translated by the Rev. J. S. Watson, M.A. 5*s*.

—— **On the Nature of the Gods, Divination, Fate, Laws, a Republic, Consulship.** Translated by Prof. C. D. Yonge, M.A., and Francis Barham. 5*s*.

—— **Academics, De Finibus, and Tusculan Questions.** By Prof. C. D. Yonge, M.A. 5*s*.

CICERO'S Offices; or, Moral Duties. Cato Major, an Essay on Old Age; Lælius, an Essay on Friendship; Scipio's Dream; Paradoxes; Letter to Quintus on Magistrates. Translated by C. R. Edmonds. 3*s*. 6*d*.

CORNELIUS NEPOS.—*See* JUSTIN.

CLARK'S (Hugh) Introduction to Heraldry. 18th Edition, Revised and Enlarged by J. R. Planché, Rouge Croix. With nearly 1000 Illustrations. 5*s*. Or with the Illustrations Coloured, 15*s*.

CLASSIC TALES, containing Rasselas, Vicar of Wakefield, Gulliver's Travels, and The Sentimental Journey. 3*s*. 6*d*.

COLERIDGE'S (S. T.) Friend. A Series of Essays on Morals, Politics, and Religion. 3*s*. 6*d*.

—— **Aids to Reflection,** and the CONFESSIONS OF AN INQUIRING SPIRIT, to which are added the ESSAYS ON FAITH and the BOOK OF COMMON PRAYER. 3*s*. 6*d*.

—— **Lectures and Notes on Shakespeare and other English Poets.** Edited by T. Ashe. 3*s*. 6*d*.

—— **Biographia Literaria;** together with Two Lay Sermons. 3*s*. 6*d*.

—— **Table-Talk and Omniana.** Edited by T. Ashe, B.A. 3*s*. 6*d*.

—— **Miscellanies, Æsthetic and Literary;** to which is added, THE THEORY OF LIFE. Collected and arranged by T. Ashe, B.A. 3*s*. 6*d*.

COMTE'S Positive Philosophy. Translated and condensed by Harriet Martineau. With Introduction by Frederic Harrison. 3 vols. 5*s*. each.

COMTE'S Philosophy of the Sciences, being an Exposition of the Principles of the *Cours de Philosophie Positive*. By G. H. Lewes. 5*s*.

CONDÉ'S History of the Dominion of the Arabs in Spain. Translated by Mrs. Foster. 3 vols. 3*s*. 6*d*. each.

COOPER'S Biographical Dictionary. Containing Concise Notices (upwards of 15,000) of Eminent Persons of all Ages and Countries. By Thompson Cooper, F.S.A. With a Supplement, bringing the work down to 1883. 2 vols. 5*s.* each.

COXE'S Memoirs of the Duke of Marlborough. With his original Correspondence. By W. Coxe, M.A., F.R.S. Revised edition by John Wade. 3 vols. 3*s.* 6*d.* each.

*** An Atlas of the plans of Marlborough's campaigns, 4to. 10*s.* 6*d.*

— History of the House of Austria (1218–1792). With a Continuation from the Accession of Francis I. to the Revolution of 1848. 4 vols. 3*s.* 6*d.* each.

CRAIK'S (G. L.) Pursuit of Knowledge under Difficulties. Illustrated by Anecdotes and Memoirs. Revised edition, with numerous Woodcut Portraits and Plates. 5*s.*

CRUIKSHANK'S Punch and Judy. The Dialogue of the Puppet Show; an Account of its Origin, &c. With 24 Illustrations, and Coloured Plates, designed and engraved by G. Cruikshank. 5*s.*

CUNNINGHAM'S Lives of the Most Eminent British Painters. A New Edition, with Notes and Sixteen fresh Lives. By Mrs. Heaton. 3 vols. 3*s.* 6*d.* each.

DANTE. Divina Commedia. Translated by the Rev. H. F. Cary, M.A. 3*s.* 6*d.*

— Translated into English Verse by I. C. Wright, M.A. 3rd Edition, revised. With Portrait, and 34 Illustrations on Steel, after Flaxman.

DANTE. The Inferno. A Literal Prose Translation, with the Text of the Original printed on the same page. By John A. Carlyle, M.D. 5*s.*

— The Purgatorio. A Literal Prose Translation, with the Text printed on the same page. By W. S. Dugdale. 5*s.*

DE COMMINES (Philip), Memoirs of. Containing the Histories of Louis XI. and Charles VIII., Kings of France, and Charles the Bold, Duke of Burgundy. Together with the Scandalous Chronicle, or Secret History of Louis XI., by Jean de Troyes. Translated by Andrew R. Scoble. With Portraits. 2 vols. 3*s.* 6*d.* each.

DEFOE'S Novels and Miscellaneous Works. With Prefaces and Notes, including those attributed to Sir W. Scott. 7 vols. 3*s.* 6*d.* each.

I.—Captain Singleton, and Colonel Jack.

II.—Memoirs of a Cavalier, Captain Carleton, Dickory Cronke, &c.

III.—Moll Flanders, and the History of the Devil.

IV.—Roxana, and Life of Mrs. Christian Davies.

V.—History of the Great Plague of London, 1665; The Storm (1703); and the True-born Englishman.

VI.—Duncan Campbell, New Voyages round the World, and Political Tracts.

VII.—Robinson Crusoe.

DE LOLME on the Constitution of England. Edited by John Macgregor. 3*s.* 6*d.*

DEMMIN'S History of Arms and Armour, from the Earliest Period. By Auguste Demmin. Translated by C. C. Black, M.A. With nearly 2000 Illustrations. 7*s*. 6*d*.

DEMOSTHENES' Orations. Translated by C. Rann Kennedy. 5 vols. Vol. I., 3*s*. 6*d*.; Vols. II.–V., 5*s*. each.

DE STAËL'S Corinne or Italy. By Madame de Stael. Translated by Emily Baldwin and Paulina Driver. 3*s*. 6*d*.

DEVEY'S Logic, or the Science of Inference. A Popular Manual. By J. Devey. 5*s*.

DICTIONARY of Latin and Greek Quotations; including Proverbs, Maxims, Mottoes, Law Terms and Phrases. With all the Quantities marked, and English Translations. With Index Verborum (622 pages). 5*s*.

DICTIONARY of Obsolete and Provincial English. Compiled by Thomas Wright, M.A., F.S A., &c. 2 vols. 5*s*. each.

DIDRON'S Christian Iconography: a History of Christian Art in the Middle Ages. Translated by E. J. Millington and completed by Margaret Stokes. With 240 Illustrations. 2 vols. 5*s*. each.

DIOGENES LAERTIUS. Lives and Opinions of the Ancient Philosophers. Translated by Prof. C. D. Yonge, M.A. 5*s*.

DOBREE'S Adversaria. Edited by the late Prof. Wagner. 2 vols. 5*s*. each.

DODD'S Epigrammatists. A Selection from the Epigrammatic Literature of Ancient, Mediæval, and Modern Times. By the Rev. Henry Philip Dodd, M.A. Oxford. 2nd Edition, revised and enlarged. 6*s*.

DONALDSON'S The Theatre of the Greeks. A Treatise on the History and Exhibition of the Greek Drama. With numerous Illustrations and 3 Plans. By John William Donaldson, D.D. 5*s*.

DRAPER'S History of the Intellectual Development of Europe. By John William Draper, M.D., LL.D. 2 vols. 5*s*. each.

DUNLOP'S History of Fiction. A new Edition. Revised by Henry Wilson. 2 vols. 5*s*. each.

DYER (Dr T. H.). Pompeii: its Buildings and Antiquities. By T. H. Dyer, LL.D. With nearly 300 Wood Engravings, a large Map, and a Plan of the Forum. 7*s*. 6*d*.

—— **The City of Rome**: its History and Monuments. With Illustrations. 5*s*.

DYER (T. F. T.) British Popular Customs, Present and Past. An Account of the various Games and Customs associated with Different Days of the Year in the British Isles, arranged according to the Calendar. By the Rev. T. F. Thiselton Dyer, M.A. 5*s*.

EBERS' Egyptian Princess. An Historical Novel. By George Ebers. Translated by E. S. Buchheim. 3*s*. 6*d*.

EDGEWORTH'S Stories for Children. With 8 Illustrations by L. Speed. 3*s*. 6*d*.

ELZE'S William Shakespeare. —*See* SHAKESPEARE.

EMERSON'S Works. 3 vols 3*s*. 6*d*. each.

I.—Essays, Lectures and Poems.

II.—English Traits, Nature, and Conduct of Life.

EMERSON'S WORKS *continued.*

III.—Society and Solitude—Letters and Social aims — Miscellaneous Papers (hitherto uncollected) — May Day, and other Poems.

ELLIS (G.) Specimens of Early English Metrical Romances. With an Historical Introduction on the Rise and Progress of Romantic Composition in France and England. Revised Edition. By J. O. Halliwell, F.R.S. 5*s.*

ENNEMOSER'S History of Magic. Translated by William Howitt. 2 vols. 5*s.* each.

EPICTETUS, The Discourses of. With the ENCHEIRIDION and Fragments. Translated by George Long, M.A. 5*s.*

EURIPIDES. A New Literal Translation in Prose. By E P. Coleridge, M.A. 2 vols. 5*s.* each.

EUTROPIUS.—*See* JUSTIN.

EUSEBIUS PAMPHILUS, Ecclesiastical History of. Translated by Rev. C. F. Cruse, M.A. 5*s.*

EVELYN'S Diary and Correspondendence. Edited from the Original MSS. by W. Bray, F.A.S. With 45 engravings. 4 vols. 5*s.* each.

FAIRHOLT'S Costume in England. A History of Dress to the end of the Eighteenth Century. 3rd Edition, revised, by Viscount Dillon, V.P.S.A. Illustrated with above 700 Engravings. 2 vols. 5*s.* each.

FIELDING'S Adventures of Joseph Andrews and his Friend Mr. Abraham Adams. With Cruikshank's Illustrations. 3*s.* 6*d.*

—— **History of Tom Jones, a Foundling.** With Cruikshank's Illustrations. 2 vols. 3*s.* 6*d.* each.

—— **Amelia.** With Cruikshank's Illustrations. 5*s.*

FLAXMAN'S Lectures on Sculpture. By John Flaxman, R.A. With Portrait and 53 Plates. 6*s.*

FLORENCE of WORCESTER'S Chronicle, with the Two Continuations: comprising Annals of English History, from the Departure of the Romans to the Reign of Edward I. Translated by Thomas Forester, M.A. 5*s.*

FOSTER'S (John) Life and Correspondence. Edited by J. E. Ryland. 2 vols. 3*s.* 6*d.* each.

—— **Critical Essays.** Edited by J. E. Ryland. 2 vols. 3*s.* 6*d.* each.

—— **Essays:** on Decision of Character; on a Man's writing Memoirs of Himself; on the epithet Romantic; on the aversion of Men of Taste to Evangelical Religion. 3*s.* 6*d.*

—— **Essays** on the Evils of Popular Ignorance; to which is added, a Discourse on the Propagation of Christianity in India. 3*s.* 6*d.*

—— **Essays** on the Improvement of Time. With NOTES OF SERMONS and other Pieces. 3*s.* 6*d.*

GASPARY'S History of Italian Literature. Translated by Herman Oelsner, M.A., Ph.D. Vol. I. 3*s.* 6*d.*

GEOFFREY OF MONMOUTH, Chronicle of.—*See Old English Chronicles.*

GESTA ROMANORUM, or Entertaining Moral Stories invented by the Monks. Translated by the Rev. Charles Swan. Revised Edition, by Wynnard Hooper, B.A. 5*s.*

GILDAS, Chronicles of.—*See Old English Chronicles.*

GIBBON'S Decline and Fall of the Roman Empire. Complete and Unabridged, with Variorum Notes. Edited by an English Churchman. With 2 Maps and Portrait. 7 vols. 3*s*. 6*d*. each.

GILBART'S History, Principles, and Practice of Banking. By the late J. W. Gilbart, F.R.S. New Edition, revised by A. S. Michie. 2 vols. 10*s*.

GIL BLAS, The Adventures of. Translated from the French of Lesage by Smollett. With 24 Engravings on Steel, after Smirke, and 10 Etchings by George Cruikshank. 6*s*.

GIRALDUS CAMBRENSIS' Historical Works. Translated by Th. Forester, M.A., and Sir R. Colt Hoare. Revised Edition, Edited by Thomas Wright, M.A., F.S.A. 5*s*.

GOETHE'S Faust. Part I. German Text with Hayward's Prose Translation and Notes. Revised by C. A. Buchheim, Ph.D. 5*s*.

GOETHE'S Works. Translated into English by various hands. 14 vols. 3*s*. 6*d*. each.

I. and II.—Autobiography and Annals.
III.—Faust. Two Parts, complete. (Swanwick.)
IV.—Novels and Tales.
V.—Wilhelm Meister's Apprenticeship.
VI.—Conversations with Eckermann and Soret.
VIII.—Dramatic Works.
IX.—Wilhelm Meister's Travels.
X.—Tour in Italy, and Second Residence in Rome.
XI.—Miscellaneous Travels.
XII.—Early and Miscellaneous Letters.
XIII.—Correspondence with Zelter.
XIV.—Reineke Fox, West-Eastern Divan and Achilleid.

GOLDSMITH'S Works. A new Edition, by J. W. M. Gibbs. 5 vols. 3*s*. 6*d*. each.

GRAMMONT'S Memoirs of the Court of Charles II. Edited by Sir Walter Scott. Together with the BOSCOBEL TRACTS, including two not before published, &c. New Edition. 5*s*.

GRAY'S Letters. Including the Correspondence of Gray and Mason. Edited by the Rev. D. C. Tovey, M.A. Vols. I. and II. 3*s*. 6*d*. each.

GREEK ANTHOLOGY. Translated by George Burges, M.A. 5*s*.

GREEK ROMANCES of Heliodorus, Longus, and Achilles Tatius—viz., The Adventures of Theagenes & Chariclea; Amours of Daphnis and Chloe; and Loves of Clitopho and Leucippe. Translated by Rev. R. Smith, M.A. 5*s*.

GREGORY'S Letters on the Evidences, Doctrines, & Duties of the Christian Religion. By Dr. Olinthus Gregory. 3*s*. 6*d*.

GREENE, MARLOWE, and BEN JONSON. Poems of. Edited by Robert Bell. 3*s*. 6*d*.

GRIMM'S TALES. With the Notes of the Original. Translated by Mrs. A. Hunt. With Introduction by Andrew Lang, M.A. 2 vols. 3*s*. 6*d*. each.

—— **Gammer Grethel;** or, German Fairy Tales and Popular Stories. Containing 42 Fairy Tales. Trans. by Edgar Taylor. With numerous Woodcuts after George Cruikshank and Ludwig Grimm. 3*s*. 6*d*.

GROSSI'S Marco Visconti. Translated by A. F. D. The Ballads rendered into English Verse by C. M. P. 3*s*. 6*d*.

GUIZOT'S History of the English Revolution of 1640. From the Accession of Charles I. to his Death. Translated by William Hazlitt. 3*s.* 6*d.*

—— **History of Civilisation**, from the Fall of the Roman Empire to the French Revolution. Translated by William Hazlitt. 3 vols. 3*s.* 6*d.* each.

HALL'S (Rev. Robert) **Miscellaneous Works and Remains.** 3*s.* 6*d.*

HAMPTON COURT: A Short History of the Manor and Palace. By Ernest Law, B.A. With numerous Illustrations. 5*s.*

HARDWICK'S History of the Articles of Religion. By the late C. Hardwick Revised by the Rev. Francis Procter, M.A. 5*s.*

HAUFF'S Tales. The Caravan—The Sheik of Alexandria—The Inn in the Spessart. Trans. from the German by S. Mendel. 3*s.* 6*d.*

HAWTHORNE'S Tales. 4 vols. 3*s.* 6*d.* each.

I.—Twice-told Tales, and the Snow Image.

II.—Scarlet Letter, and the House with the Seven Gables.

III.—Transformation [The Marble Faun], and Blithedale Romance.

IV.—Mosses from an Old Manse.

HAZLITT'S Table-talk. Essays on Men and Manners. By W. Hazlitt. 3*s.* 6*d.*

—— **Lectures on the Literature of the Age of Elizabeth** and on Characters of Shakespeare's Plays. 3*s.* 6*d.*

—— **Lectures on the English Poets**, and on the English Comic Writers. 3*s.* 6*d.*

—— **The Plain Speaker.** Opinions on Books, Men, and Things. 3*s.* 6*d.*

—— **Round Table.** 3*s.* 6*d.*

HAZLITT'S Sketches and Essays. 3*s.* 6*d.*

—— **The Spirit of the Age**; or, Contemporary Portraits. Edited by W. Carew Hazlitt. 3*s.* 6*d.*

HEATON'S Concise History of Painting. New Edition, revised by Cosmo Monkhouse. 5*s.*

HEGEL'S Lectures on the Philosophy of History. Translated by J. Sibree, M.A.

HEINE'S Poems, Complete Translated by Edgar A. Bowring, C.B. 3*s.* 6*d.*

—— **Travel-Pictures**, including the Tour in the Harz, Norderney, and Book of Ideas, together with the Romantic School. Translated by Francis Storr. A New Edition, revised throughout. With Appendices and Maps. 3*s.* 6*d.*

HELP'S Life of Christopher Columbus, the Discoverer of America. By Sir Arthur Helps, K.C.B. 3*s.* 6*d.*

—— **Life of Hernando Cortes**, and the Conquest of Mexico. 2 vols. 3*s.* 6*d.* each.

—— **Life of Pizarro.** 3*s.* 6*d.*

—— **Life of Las Casas** the Apostle of the Indies. 3*s.* 6*d.*

HENDERSON (E.) Select Historical Documents of the Middle Ages, including the most famous Charters relating to England, the Empire, the Church, &c., from the 6th to the 14th Centuries. Translated from the Latin and edited by Ernest F. Henderson, A.B., A.M., Ph.D. 5*s.*

HENFREY'S Guide to English Coins, from the Conquest to the present time. New and revised Edition by C. F. Keary, M.A., F.S.A. 6*s.*

HENRY OF HUNTINGDON'S History of the English. Translated by T. Forester, M.A. 5*s.*

HENRY'S (Matthew) Exposition of the Book of the Psalms. 5*s.*

HELIODORUS. Theagenes and Chariclea. — *See* GREEK ROMANCES.

HERODOTUS. Translated by the Rev. Henry Cary, M.A. 3*s.* 6*d.*

—— **Notes on.** Original and Selected from the best Commentators. By D. W. Turner, M A. With Coloured Map. 5*s.*

—— **Analysis and Summary of** By J. T. Wheeler. 5*s.*

HESIOD, CALLIMACHUS, and THEOGNIS. Translated by the Rev. J. Banks, M.A. 5*s.*

HOFFMANN'S (E. T. W.) The Serapion Brethren. Translated from the German by Lt.-Col. Alex. Ewing. 2 vols. 3*s.* 6*d.* each.

HOLBEIN'S Dance of Death and Bible Cuts. Upwards of 150 Subjects, engraved in facsimile, with Introduction and Descriptions by Francis Douce and Dr. Thomas Frognall Dibden. 5*s.*

HOMER'S Iliad. Translated into English Prose by T. A. Buckley, B.A. 5*s.*

—— **Odyssey.** Hymns, Epigrams, and Battle of the Frogs and Mice. Translated into English Prose by T. A. Buckley, B.A. 5*s.*

—— *See also* POPE.

HOOPER'S (G.) Waterloo: The Downfall of the First Napoleon: a History of the Campaign of 1815. By George Hooper. With Maps and Plans. 3*s.* 6*d.*

—— **The Campaign of Sedan:** The Downfall of the Second Empire, August - September, 1870. With General Map and Six Plans of Battle. 3*s.* 6*d.*

HORACE. A new literal Prose translation, by A. Hamilton Bryce, LL.D. 3*s.* 6*d.*

HUGO'S (Victor) Dramatic Works. Hernani—Ruy Blas—The King's Diversion. Translated by Mrs. Newton Crosland and F. L. Slous. 3*s.* 6*d.*

—— **Poems, chiefly Lyrical.** Translated by various Writers, now first collected by J. H. L. Williams. 3*s.* 6*d.*

HUMBOLDT'S Cosmos. Translated by E. C. Otté, B H. Paul, and W. S. Dallas, F.L.S. 5 vols. 3*s.* 6*d.* each, excepting Vol. V. 5*s.*

—— **Personal Narrative** of his Travels to the Equinoctial Regions of America during the years 1799–1804. Translated by T. Ross. 3 vols. 5*s.* each.

—— **Views of Nature.** Translated by E. C. Otté and H. G. Bohn. 5*s.*

HUMPHREYS' Coin Collector's Manual. By H. N. Humphreys. with upwards of 140 Illustrations on Wood and Steel. 2 vols. 5*s.* each.

HUNGARY: its History and Revolution, together with a copious Memoir of Kossuth. 3*s.* 6*d.*

HUTCHINSON (Colonel). Memoirs of the Life of. By his Widow, Lucy: together with her Autobiography, and an Account of the Siege of Lathom House. 3*s.* 6*d.*

HUNT'S Poetry of Science. By Richard Hunt. 3rd Edition, revised and enlarged. 5*s.*

INDIA BEFORE THE SEPOY MUTINY. A Pictorial, Descriptive, and Historical Account, from the Earliest Times to the Annexation of the Punjab. with upwards of 100 Engravings on Wood, and a Map. 5*s.*

INGULPH'S Chronicles of the Abbey of Croyland, with the CONTINUATION by Peter of Blois, and other Writers. Translated by H. T. Riley, M.A. 5*s.*

IRVING'S (Washington) Complete Works. 15 vols. With Portraits, &c. 3*s.* 6*d.* each.

I.—Salmagundi, Knickerbocker's History of New York.

II.—The Sketch-Book, and the Life of Oliver Goldsmith.

III.—Bracebridge Hall, Abbotsford and Newstead Abbey.

IV.—The Alhambra, Tales of a Traveller.

V.—Chronicle of the Conquest of Granada, Legends of the Conquest of Spain.

VI. & VII.—Life and Voyages of Columbus, together with the Voyages of his Companions.

VIII.—Astoria, A Tour on the Prairies.

XI.—Life of Mahomet, Lives of the Successors of Mahomet.

X.—Adventures of Captain Bonneville, U.S.A., Wolfert's Roost.

XI.—Biographies and Miscellaneous Papers.

XII.-XV.—Life of George Washington. 4 vols.

—— **Life and Letters.** By his Nephew, Pierre E. Irving. 2 vols. 3*s.* 6*d.* each.

ISOCRATES, The Orations of. Translated by J. H. Freese, M.A. Vol. I. 5*s.*

JAMES'S (G. P. R.) Life of Richard Cœur de Lion. 2 vols. 3*s.* 6*d.* each.

—— **The Life and Times of Louis XIV.** 2 vols. 3*s.* 6*d.* each.

JAMESON'S (Mrs.) Shakespeare's Heroines. Characteristics of Women: Moral, Poetical, and Historical. By Mrs. Jameson. 3*s.* 6*d.*

JESSE'S (E.) Anecdotes of Dogs. With 40 Woodcuts and 34 Steel Engravings. 5*s.*

JESSE'S (J. H.). Memoirs of the Court of England during the Reign of the Stuarts, including the Protectorate. 3 vols. With 42 Portraits. 5*s.* each.

—— **Memoirs of the Pretenders and their Adherents.** With 6 Portraits. 5*s.*

JOHNSON'S Lives of the Poets. Edited by Mrs. Alexander Napier, with Introduction by Professor Hales. 3 vols. 3*s.* 6*d.* each.

JOSEPHUS (Flavius), The Works of. Whiston's Translation, revised by Rev. A. R. Shilleto, M.A With Topographical and Geographical Notes by Colonel Sir C. W. Wilson, K.C.B. 5 vols. 3*s.* 6*d.* each.

JOYCE'S Scientific Dialogues. With numerous Woodcuts. 5*s.*

JUKES-BROWNE (A. J.), The Building of the British Isles: a Study in Geographical Evolution. Illustrated by numerous Maps and Woodcuts. 2nd Edition, revised, 7*s.* 6*d.*

—— **Student's Handbook of Physical Geology.** With numerous Diagrams and Illustrations. 2nd Edition, much enlarged, 7*s.* 6*d.*

JULIAN, the Emperor. Containing Gregory Nazianzen's Two Invectives and Libanus' Monody, with Julian's extant Theosophical Works. Translated by C. W. King, M.A. 5*s.*

JUSTIN, CORNELIUS NEPOS, and EUTROPIUS. Translated by the Rev. J. S. Watson, M.A. 5*s.*

JUVENAL, PERSIUS, SULPICIA and LUCILIUS. Translated by L. Evans, M.A. 5*s.*

JUNIUS'S Letters. With all the Notes of Woodfall's Edition, and important Additions. 2 vols. 3*s.* 6*d.* each.

KANT'S Critique of Pure Reason. Translated by J. M. D. Meiklejohn. 5*s*.

—— **Prolegomena and Metaphysical Foundations of Natural Science.** Translated by E. Belfort Bax. 5*s*.

KEIGHTLEY'S (Thomas) Mythology of Ancient Greece and Italy. 4th Edition, revised by Leonard Schmitz, Ph.D., LL.D. With 12 Plates from the Antique. 5*s*.

—— **Fairy Mythology,** illustrative of the Romance and Superstition of Various Countries. Revised Edition, with Frontispiece by Cruikshank. 5*s*.

LA FONTAINE'S Fables. Translated into English Verse by Elizur Wright. New Edition, with Notes by J. W. M. Gibbs. 3*s*. 6*d*.

LAMARTINE'S History of the Girondists. Translated by H. T. Ryde. 3 vols. 3*s*. 6*d*. each.

—— **History of the Restoration of Monarchy in France** (a Sequel to the History of the Girondists). 4 vols. 3*s*. 6*d*. each.

—— **History of the French Revolution of 1848.** 3*s*. 6*d*.

LAMB'S (Charles) Essays of Elia and Eliana. Complete Edition. 3*s*. 6*d*.

—— **Specimens of English Dramatic Poets of the Time of Elizabeth.** 3*s*. 6*d*.

—— **Memorials and Letters of Charles Lamb.** By Serjeant Talfourd. New Edition, revised, by W. Carew Hazlitt. 2 vols. 3*s*. 6*d*. each.

LANZI'S History of Painting in Italy, from the Period of the Revival of the Fine Arts to the End of the Eighteenth Century. Translated by Thomas Roscoe. 3 vols. 3*s*. 6*d*. each.

LAPPENBERG'S History of England under the Anglo-Saxon Kings. Translated by B. Thorpe, F.S.A. New edition, revised by E. C. Otté. 2 vols. 3*s*. 6*d*. each.

LECTURES ON PAINTING, by Barry, Opie, Fuseli. Edited by R. Wornum. 5*s*.

LEONARDO DA VINCI'S Treatise on Painting. Translated by J. F. Rigaud, R.A., With a Life of Leonardo by John William Brown. With numerous Plates. 5*s*.

LEPSIUS'S Letters from Egypt, Ethiopia, and the Peninsula of Sinai. Translated by L. and J. B. Horner. With Maps. 5*s*.

LESSING'S Dramatic Works, Complete. Edited by Ernest Bell, M.A. With Memoir of Lessing by Helen Zimmern. 2 vols. 3*s*. 6*d*. each.

—— **Laokoon, Dramatic Notes, and the Representation of Death by the Ancients.** Translated by E. C. Beasley and Helen Zimmern. Edited by Edward Bell, M.A. With a Frontispiece of the Laokoon group. 3*s*. 6*d*.

LILLY'S Introduction to Astrology. With a GRAMMAR OF ASTROLOGY and Tables for Calculating Nativities, by Zadkiel. 5*s*.

LIVY'S History of Rome. Translated by Dr. Spillan, C. Edmonds, and others. 4 vols. 5*s*. each.

LOCKE'S Philosophical Works. Edited by J. A. St. John. 2 vols. 3*s*. 6*d*. each.

—— **Life and Letters:** By Lord King. 3*s*. 6*d*.

LOCKHART (J. G.)—*See* BURNS.

LODGE'S Portraits of Illustrious Personages of Great Britain, with Biographical and Historical Memoirs. 240 Portraits engraved on Steel, with the respective Biographies unabridged. 8 vols. 5*s.* each.

LONGFELLOW'S Prose Works. With 16 full-page Wood Engravings. 5*s.*

LOUDON'S (Mrs.) Natural History. Revised edition, by W. S. Dallas, F.L.S. With numerous Woodcut Illus. 5*s.*

LOWNDES' Bibliographer's Manual of English Literature. Enlarged Edition. By H. G. Bohn. 6 vols. cloth, 5*s.* each. Or 4 vols. half morocco, 2*l.* 2*s.*

LONGUS. Daphnis and Chloe. —*See* GREEK ROMANCES.

LUCAN'S Pharsalia. Translated by H. T. Riley, M.A. 5*s.*

LUCIAN'S Dialogues of the Gods, of the Sea Gods, and of the Dead. Translated by Howard Williams, M.A. 5*s.*

LUCRETIUS. Translated by the Rev. J. S. Watson, M.A. 5*s.*

LUTHER'S Table-Talk. Translated and Edited by William Hazlitt. 3*s.* 6*d.*

—— **Autobiography.** — *See* MICHELET.

MACHIAVELLI'S History of Florence, together with the Prince, Savonarola, various Historical Tracts, and a Memoir of Machiavelli. 3*s.* 6*d.*

MALLET'S Northern Antiquities, or an Historical Account of the Manners, Customs, Religions and Laws, Maritime Expeditions and Discoveries, Language and Literature, of the Ancient Scandinavians. Translated by Bishop Percy. Revised and Enlarged Edition, with a Translation of the PROSE EDDA, by J. A. Blackwell. 5*s.*

MANTELL'S (Dr.) Petrifactions and their Teachings. With numerous illustrative Woodcuts. 6*s.*

—— **Wonders of Geology.** 8th Edition, revised by T. Rupert Jones, F.G.S. With a coloured Geological Map of England, Plates, and upwards of 200 Woodcuts. 2 vols. 7*s.* 6*d.* each.

MANZONI. The Betrothed: being a Translation of 'I Promessi Sposi.' By Alessandro Manzoni. With numerous Woodcuts. 5*s.*

MARCO POLO'S Travels; the Translation of Marsden revised by T. Wright, M.A., F.S.A. 5*s.*

MARRYAT'S (Capt. R.N.) Masterman Ready. With 93 Woodcuts. 3*s.* 6*d.*

—— **Mission;** or, Scenes in Africa. Illustrated by Gilbert and Dalziel. 3*s.* 6*d.*

—— **Pirate and Three Cutters.** With 8 Steel Engravings, from Drawings by Clarkson Stanfield, R.A. 3*s.* 6*d.*

—— **Privateersman.** 8 Engravings on Steel. 3*s.* 6*d*

—— **Settlers in Canada.** 10 Engravings by Gilbert and Dalziel. 3*s.* 6*d.*

—— **Poor Jack.** With 16 Illustrations after Clarkson Stansfield, R.A. 3*s.* 6*d.*

—— **Peter Simple.** With 8 full-page Illustrations. 3*s.* 6*d.*

—— **Midshipman Easy.** With 8 full-page Illustrations. 3*s.* 6*d.*

MARTIAL'S Epigrams, complete. Translated into Prose, each accompanied by one or more Verse Translations selected from the Works of English Poets, and other sources. 7*s.* 6*d.*

MARTINEAU'S (Harriet) History of England, from 1800–1815. 3*s*. 6*d*.

—— **History of the Thirty Years' Peace,** A.D. 1815–46. 4 vols. 3*s*. 6*d*. each.

—— *See Comte's Positive Philosophy.*

MATTHEW PARIS'S English History, from the Year 1235 to 1273. Translated by Rev. J. A. Giles, D.C.L. 3 vols. 5*s*. each.

MATTHEW OF WESTMINSTER'S Flowers of History, from the beginning of the World to A.D. 1307. Translated by C. D. Yonge, M.A. 2 vols. 5*s*. each.

MAXWELL'S Victories of Wellington and the British Armies. Frontispiece and 5 Portraits. 5*s*.

MENZEL'S History of Germany, from the Earliest Period to 1842. 3 vols. 3*s*. 6*d*. each.

MICHAEL ANGELO AND RAPHAEL, their Lives and Works. By Duppa and Quatremere de Quincy. With Portraits, and Engravings on Steel. 5*s*.

MICHELET'S Luther's Autobiography. Trans. by William Hazlitt. With an Appendix (110 pages) of Notes. 3*s*. 6*d*.

—— **History of the French Revolution** from its earliest indications to the flight of the King in 1791. 3*s*. 6*d*.

MIGNET'S History of the French Revolution, from 1789 to 1814. 3*s*. 6*d*.

MILL (J. S.). Early Essays by John Stuart Mill. Collected from various sources by J. W. M. Gibbs. 3*s*. 6*d*.

MILLER (Professor). History Philosophically Illustrated, from the Fall of the Roman Empire to the French Revolution. 4 vols. 3*s*. 6*d*. each.

MILTON'S Prose Works. Edited by J. A. St. John. 5 vols. 3*s*. 6*d*. each.

—— **Poetical Works,** with a Memoir and Critical Remarks by James Montgomery, an Index to Paradise Lost, Todd's Verbal Index to all the Poems, and a Selection of Explanatory Notes by Henry G. Bohn. Illustrated with 120 Wood Engravings from Drawings by W. Harvey. 2 vols. 3*s*. 6*d*. each.

MITFORD'S (Miss) Our Village Sketches of Rural Character and Scenery. With 2 Engravings on Steel. 2 vols. 3*s*. 6*d*. each.

MOLIERE'S Dramatic Works. A new Translation in English Prose, by C. H. Wall. 3 vols. 3*s*. 6*d*. each.

MONTAGU. The Letters and Works of Lady Mary Wortley Montagu. Edited by her great-grandson, Lord Wharncliffe's Edition, and revised by W. Moy Thomas. New Edition, revised, with 5 Portraits. 2 vols. 5*s*. each.

MONTAIGNE'S Essays. Cotton's Translation, revised by W. C. Hazlitt. New Edition. 3 vols. 3*s*. 6*d*. each.

MONTESQUIEU'S Spirit of Laws. New Edition, revised and corrected. By J. V. Pritchard, A.M. 2 vols. 3*s*. 6*d*. each.

MOTLEY (J. L.). The Rise of the Dutch Republic. A History. By John Lothrop Motley. New Edition, with Biographical Introduction by Moncure D. Conway. 3 vols. 3*s*. 6*d*. each.

MORPHY'S Games of Chess. Being the Matches and best Games played by the American Champion, with Explanatory and Analytical Notes by J. Löwenthal. 5*s*.

MUDIE'S British Birds; or, History of the Feathered Tribes of the British Islands. Revised by W. C. L. Martin. With 52 Figures of Birds and 7 Coloured Plates of Eggs. 2 vols.

NEANDER (Dr. A.). **History of the Christian Religion and Church.** Trans. from the German by J. Torrey. 10 vols. 3*s*. 6*d*. each.

—— **Life of Jesus Christ.** Translated by J. McClintock and C. Blumenthal. 3*s*. 6*d*.

—— **History of the Planting and Training of the Christian Church by the Apostles.** Translated by J. E. Ryland. 2 vols. 3*s*. 6*d*. each.

—— **Memorials of Christian Life in the Early and Middle Ages**; including Light in Dark Places. Trans. by J. E. Ryland. 3*s*. 6*d*.

NIBELUNGEN LIED. The **Lay of the Nibelungs**, metrically translated from the old German text by Alice Horton, and edited by Edward Bell, M.A. To which is prefixed the Essay on the Nibelungen Lied by Thomas Carlyle. 5*s*.

NEW TESTAMENT (The) in Greek. Griesbach's Text, with various Readings at the foot of the page, and Parallel References in the margin; also a Critical Introduction and Chronological Tables. By an eminent Scholar, with a Greek and English Lexicon. 3rd Edition, revised and corrected. Two Facsimiles of Greek Manuscripts. 900 pages. 5*s*.

The Lexicon may be had separately, price 2*s*.

NICOLINI'S History of the Jesuits: their Origin, Progress, Doctrines, and Designs. With 8 Portraits. 5*s*.

NORTH (R.) **Lives of the Right** Hon. Francis North, Baron Guildford, the Hon. Sir Dudley North, and the Hon. and Rev. Dr. John North. By the Hon. Roger North. Together with the Autobiography of the Author. Edited by Augustus Jessopp, D.D. 3 vols. 3*s*. 6*d*. each.

NUGENT'S (Lord) **Memorials of Hampden, his Party and Times.** With a Memoir of the Author, an Autograph Letter, and Portrait. 5*s*.

OCKLEY (S.) **History of the Saracens and their Conquests in Syria, Persia, and Egypt.** By Simon Ockley, B.D., Professor of Arabic in the University of Cambridge. 3*s*. 6*d*.

OLD ENGLISH CHRONICLES, including Ethelwerd's Chronicle, Asser's Life of Alfred, Geoffrey of Monmouth's British History, Gildas, Nennius, and the spurious chronicle of Richard of Cirencester. Edited by J. A. Giles, D.C.L. 5*s*.

OMAN (J. C.) **The Great Indian Epics**: the Stories of the RAMAYANA and the MAHABHARATA. By John Campbell Oman, Principal of Khalsa College, Amritsar. With Notes, Appendices, and Illustrations. 3*s*. 6*d*.

ORDERICUS VITALIS' Ecclesiastical History of England and Normandy. Translated by T. Forester, M.A. To which is added the CHRONICLE OF ST. EVROULT. 4 vols. 5*s*. each.

OVID'S Works, complete. Literally translated into Prose. 3 vols. 5*s*. each.

PASCAL'S Thoughts. Translated from the Text of M. Auguste Molinier by C. Kegan Paul. 3rd Edition. 3*s*. 6*d*.

PAULI'S (Dr. R.) Life of Alfred the Great. Translated from the German. To which is appended Alfred's ANGLO-SAXON VERSION OF OROSIUS. With a literal Translation interpaged, Notes, and an ANGLO-SAXON GRAMMAR and GLOSSARY, by B. Thorpe. 5*s*.

PAUSANIAS' Description of Greece. Newly translated by A. R. Shilleto, M.A. 2 vols. 5*s*. each.

PEARSON'S Exposition of the Creed. Edited by E. Walford, M.A. 5*s*.

PEPYS' Diary and Correspondence. Deciphered by the Rev. J. Smith, M.A., from the original Shorthand MS. in the Pepysian Library. Edited by Lord Braybrooke. 4 vols. With 31 Engravings. 5*s*. each.

PERCY'S Reliques of Ancient English Poetry. With an Essay on Ancient Minstrels and a Glossary. Edited by J. V. Pritchard, A.M. 2 vols. 3*s*. 6*d*. each.

PERSIUS.—*See* JUVENAL.

PETRARCH'S Sonnets, Triumphs, and other Poems. Translated into English Verse by various Hands. With a Life of the Poet by Thomas Campbell. With Portrait and 15 Steel Engravings. 5*s*.

PHILO-JUDÆUS, Works of. Translated by Prof. C. D. Yonge, M.A. 4 vols. 5*s*. each.

PICKERING'S History of the Races of Man, and their Geographical Distribution. With AN ANALYTICAL SYNOPSIS OF THE NATURAL HISTORY OF MAN by Dr. Hall. With a Map of the World and 12 coloured Plates. 5*s*.

PINDAR. Translated into Prose by Dawson W. Turner. To which is added the Metrical Version by Abraham Moore. 5*s*.

PLANCHÉ. History of British Costume, from the Earliest Time to the Close of the Eighteenth Century. By J. R. Planché, Somerset Herald. With upwards of 400 Illustrations. 5*s*.

PLATO'S Works. Literally translated, with Introduction and Notes. 6 vols. 5*s*. each.

I.—The Apology of Socrates, Crito, Phædo, Gorgias, Protagoras, Phædrus, Theætetus, Euthyphron, Lysis. Translated by the Rev. H. Carey.

II.—The Republic, Timæus, and Critias. Translated by Henry Davis.

III.—Meno, Euthydemus, The Sophist, Statesman, Cratylus, Parmenides, and the Banquet. Translated by G. Burges.

IV.—Philebus, Charmides, Laches, Menexenus, Hippias, Ion, The Two Alcibiades, Theages, Rivals, Hipparchus, Minos, Clitopho, Epistles. Translated by G. Burges.

V.—The Laws. Translated by G. Burges.

VI.—The Doubtful Works. Translated by G. Burges.

—— **Summary and Analysis of the Dialogues.** With Analytical Index. By A. Day, LL.D. 5*s*.

PLAUTUS'S Comedies. Translated by H. T. Riley, M.A. 2 vols. 5*s*. each.

PLINY'S Natural History. Translated by the late John Bostock, M.D., F.R.S., and H. T. Riley, M.A. 6 vols. 5*s*. each.

PLINY. The Letters of Pliny the Younger. Melmoth's translation, revised by the Rev. F. C. T. Bosanquet, M.A. 5*s*.

PLOTINUS, Select Works of. Translated by Thomas Taylor. With an Introduction containing the substance of Porphyry's Plotinus. Edited by G. R. S. Mead, B.A., M.R.A.S. 5*s*.

PLUTARCH'S Lives. Translated by A. Stewart, M.A., and George Long, M.A. 4 vols. 3s. 6d. each.

—— **Morals.** Theosophical Essays. Translated by C. W. King, M.A. 5s.

—— **Morals.** Ethical Essays. Translated by the Rev. A. R. Shilleto, M.A. 5s.

POETRY OF AMERICA. Selections from One Hundred American Poets, from 1776 to 1876. By W. J. Linton. 3s. 6d.

POLITICAL CYCLOPÆDIA. A Dictionary of Political, Constitutional, Statistical, and Forensic Knowledge; forming a Work of Reference on subjects of Civil Administration, Political Economy, Finance, Commerce, Laws, and Social Relations. 4 vols. 3s. 6d. each.

POPE'S Poetical Works. Edited, with copious Notes, by Robert Carruthers. With numerous Illustrations. 2 vols. 5s. each.

—— **Homer's Iliad.** Edited by the Rev. J. S. Watson, M.A. Illustrated by the entire Series of Flaxman's Designs. 5s.

—— **Homer's Odyssey,** with the Battle of Frogs and Mice, Hymns, &c., by other translators. Edited by the Rev. J. S. Watson, M.A. With the entire Series of Flaxman's Designs. 5s.

—— **Life,** including many of his Letters. By Robert Carruthers. With numerous Illustrations. 5s.

POUSHKIN'S Prose Tales: The Captain's Daughter—Doubrovsky—The Queen of Spades—An Amateur Peasant Girl—The Shot—The Snow Storm—The Postmaster—The Coffin Maker—Kirdjali—The Egyptian Nights—Peter the Great's Negro. Translated by T. Keane. 3s. 6d.

PRESCOTT'S Conquest of Mexico. Copyright edition, with the notes by John Foster Kirk, and an introduction by G. P. Winship. 3 vols. 3s. 6d. each.

—— **Conquest of Peru.** Copyright edition, with the notes of John Foster Kirk. 2 vols. 3s. 6d. each.

—— **Reign of Ferdinand and Isabella.** Copyright edition, with the notes of John Foster Kirk. 3 vols. 3s. 6d. each.

PROPERTIUS. Translated by Rev. P. J. F. Gantillon, M.A., and accompanied by Poetical Versions, from various sources. 3s. 6d.

PROVERBS, Handbook of. Containing an entire Republication of Ray's Collection of English Proverbs, with his additions from Foreign Languages and a complete Alphabetical Index; in which are introduced large additions as well of Proverbs as of Sayings, Sentences, Maxims, and Phrases, collected by H. G. Bohn. 5s.

PROVERBS, A Polyglot of Foreign. Comprising French, Italian, German, Dutch, Spanish, Portuguese, and Danish. With English Translations & a General Index by H. G. Bohn. 5s.

POTTERY AND PORCELAIN, and other Objects of Vertu. Comprising an Illustrated Catalogue of the Bernal Collection of Works of Art, with the prices at which they were sold by auction, and names of the possessors. To which are added, an Introductory Lecture on Pottery and Porcelain, and an Engraved List of all the known Marks and Monograms. By Henry G. Bohn. With numerous Wood Engravings, 5s.; or with Coloured Illustrations, 10s. 6d.

PROUT'S (Father) Reliques. Collected and arranged by Rev. F. Mahony. New issue, with 21 Etchings by D. Maclise, R.A. Nearly 600 pages. 5s.

QUINTILIAN'S Institutes of Oratory, or Education of an Orator. Translated by the Rev. J. S. Watson, M.A. 2 vols. 5*s* each.

RACINE'S (Jean) Dramatic Works. A metrical English version. By R. Bruce Boswell, M.A. Oxon. 2 vols. 3*s*. 6*d*. each.

RANKE'S History of the Popes, their Church and State, and especially of their Conflicts with Protestantism in the 16th and 17th centuries. Translated by E. Foster. 3 vols. 3*s*. 6*d*. each.

—— **History of Servia and the Servian Revolution.** With an Account of the Insurrection in Bosnia. Translated by Mrs. Kerr. 3*s*. 6*d*.

RECREATIONS in SHOOTING. By 'Craven.' With 62 Engravings on Wood after Harvey, and 9 Engravings on Steel, chiefly after A. Cooper, R.A. 5*s*.

RENNIE'S Insect Architecture. Revised and enlarged by Rev. J. G. Wood, M.A. With 186 Woodcut Illustrations. 5*s*.

REYNOLD'S (Sir J.) Literary Works. Edited by H. W. Beechy. 2 vols. 3*s*. 6*d*. each.

RICARDO on the Principles of Political Economy and Taxation. Edited by E. C. K. Gonner, M.A. 5*s*.

RICHTER (Jean Paul Friedrich). Levana, a Treatise on Education: together with the Autobiography (a Fragment), and a short Prefatory Memoir. 3*s*. 6*d*.

—— **Flower, Fruit, and Thorn Pieces**, or the Wedded Life, Death, and Marriage of Firmian Stanislaus Siebenkaes, Parish Advocate in the Parish of Kuhschnapptel. Newly translated by Lt.-Col. Alex. Ewing. 3*s*. 6*d*.

ROGER DE HOVEDEN'S Annals of English History, comprising the History of England and of other Countries of Europe from A.D. 732 to A.D. 1201. Translated by H. T. Riley, M.A. 2 vols. 5*s*. each.

ROGER OF WENDOVER'S Flowers of History, comprising the History of England from the Descent of the Saxons to A.D. 1235, formerly ascribed to Matthew Paris. Translated by J. A. Giles, D.C.L. 2 vols. 5*s*. each.

ROME in the NINETEENTH CENTURY. Containing a complete Account of the Ruins of the Ancient City, the Remains of the Middle Ages, and the Monuments of Modern Times. By C. A. Eaton. With 34 Steel Engravings. 2 vols. 5*s*. each.

—— *See* BURN and DYER.

ROSCOE'S (W.) Life and Pontificate of Leo X. Final edition, revised by Thomas Roscoe. 2 vols. 3*s*. 6*d*. each.

—— **Life of Lorenzo de' Medici**, called 'the Magnificent.' With his poems, letters, &c. 10th Edition, revised, with Memoir of Roscoe by his Son. 3*s*. 6*d*.

RUSSIA. History of, from the earliest Period, compiled from the most authentic sources by Walter K. Kelly. With Portraits. 2 vols. 3*s* 6*d*. each.

SALLUST, FLORUS, and VELLEIUS PATERCULUS. Translated by J. S. Watson, M.A. 5*s*.

SCHILLER'S Works. Translated by various hands. 7 vols. 3*s*. 6*d*. each:—

I.—History of the Thirty Years' War.

SCHILLER'S WORKS *continued.*

II.—History of the Revolt in the Netherlands, the Trials of Counts Egmont and Horn, the Siege of Antwerp, and the Disturbances in France preceding the Reign of Henry IV.

III.—Don Carlos, Mary Stuart, Maid of Orleans, Bride of Messina, together with the Use of the Chorus in Tragedy (a short Essay).

These Dramas are all translated in metre.

IV.—Robbers (with Schiller's original Preface), Fiesco, Love and Intrigue, Demetrius, Ghost Seer, Sport of Divinity.

The Dramas in this volume are translated into Prose.

V.—Poems.

VI.—Essays, Æsthetical and Philosophical

VII.—Wallenstein's Camp, Piccolomini and Death of Wallenstein, William Tell.

SCHILLER and GOETHE. Correspondence between, from A.D. 1794–1805. Translated by L. Dora Schmitz. 2 vols. 3*s*. 6*d*. each.

SCHLEGEL'S (F.) Lectures on the Philosophy of Life and the Philosophy of Language. Translated by the Rev. A. J. W. Morrison, M.A. 3*s*. 6*d*.

—— **Lectures on the History of Literature,** Ancient and Modern. Translated from the German. 3*s*. 6*d*.

—— **Lectures on the Philosophy of History.** Translated by J. B. Robertson. 3*s*. 6*d*.

SCHLEGEL'S Lectures on Modern History, together with the Lectures entitled Cæsar and Alexander, and The Beginning of our History. Translated by L. Purcell and R. H. Whitetock. 3*s*. 6*d*.

—— **Æsthetic and Miscellaneous Works.** Translated by E. J. Millington. 3*s*. 6*d*.

SCHLEGEL (A. W.) Lectures on Dramatic Art and Literature. Translated by J. Black. Revised Edition, by the Rev. A. J. W. Morrison, M.A. 3*s*. 6*d*.

SCHOPENHAUER on the Fourfold Root of the Principle of Sufficient Reason, and On the Will in Nature. Translated by Madame Hillebrand. 5*s*.

—— **Essays.** Selected and Translated. With a Biographical Introduction and Sketch of his Philosophy, by E. Belfort Bax. 5*s*.

SCHOUW'S Earth, Plants, and Man. Translated by A. Henfrey. With coloured Map of the Geography of Plants. 5*s*.

SCHUMANN (Robert). His Life and Works, by August Reissmann. Translated by A. L. Alger. 3*s*. 6*d*.

—— **Early Letters.** Originally published by his Wife. Translated by May Herbert. With a Preface by Sir George Grove, D.C.L. 3*s*. 6*d*.

SENECA on Benefits. Newly translated by A. Stewart, M.A. 3*s*. 6*d*.

—— **Minor Essays and On Clemency.** Translated by A. Stewart, M.A. 5*s*.

SHAKESPEARE DOCUMENTS. Arranged by D. H. Lambert, B.A. 3*s*. 6*d*.

SHAKESPEARE'S Dramatic Art. The History and Character of Shakespeare's Plays. By Dr. Hermann Ulrici. Translated by L. Dora Schmitz. 2 vols. 3*s*. 6*d*. each.

SHAKESPEARE (William). A Literary Biography by Karl Elze, Ph.D., LL.D. Translated by L. Dora Schmitz. 5*s*.

SHARPE (S.) The History of Egypt, from the Earliest Times till the Conquest by the Arabs, A.D. 640. By Samuel Sharpe. 2 Maps and upwards of 400 Illustrative Woodcuts. 2 vols. 5*s*. each.

SHERIDAN'S Dramatic Works, Complete. With Life by G. G. S. 3*s*. 6*d*.

SISMONDI'S History of the Literature of the South of Europe. Translated by Thomas Roscoe. 2 vols. 3*s*. 6*d*. each.

SYNONYMS and ANTONYMS, or Kindred Words and their Opposites, Collected and Contrasted by Ven. C. J. Smith, M.A. Revised Edition. 5*s*.

SYNONYMS DISCRIMINATED. A Dictionary of Synonymous Words in the English Language, showing the Accurate signification of words of similar meaning. Illustrated with Quotations from Standard Writers. With the Author's latest Corrections and Additions. Edited by the Rev. H. Percy Smith, M.A., of Balliol College, Oxford. 6*s*.

SMITH'S (Adam) The Wealth of Nations. Edited by E. Belfort Bax. 2 vols. 3*s*. 6*d*. each.

—— **Theory of Moral Sentiments;** with his Essay on the First Formation of Languages; to which is added a Memoir of the Author by Dugald Stewart. 3*s*. 6*d*.

SMYTH'S (Professor) Lectures on Modern History; from the Irruption of the Northern Nations to the close of the American Revolution. 2 vols. 3*s*. 6*d*. each.

SMYTH'S (Professor) Lectures on the French Revolution. 2 vols. 3*s*. 6*d*. each.

SMITH'S (Pye) Geology and Scripture. 2nd Edition. 5*s*.

SMOLLETT'S Adventures of Roderick Random. With short Memoir and Bibliography, and Cruikshank's Illustrations. 3*s*. 6*d*.

—— **Adventures of Peregrine Pickle,** in which are included the Memoirs of a Lady of Quality. With Bibliography and Cruikshank's Illustrations. 2 vols. 3*s*. 6*d*. each.

—— **The Expedition of Humphry Clinker.** With Bibliography and Cruikshank's Illustrations. 3*s*. 6*d*.

SOCRATES (surnamed 'Scholasticus'). The Ecclesiastical History of (A.D. 305–445). Translated from the Greek. 5*s*.

SOPHOCLES, The Tragedies of. A New Prose Translation, with Memoir, Notes, &c., by E. P. Coleridge. 5*s*.

SOUTHEY'S Life of Nelson. With Facsimiles of Nelson's writing, Portraits, Plans, and upwards of 50 Engravings on Steel and Wood. 5*s*.

—— **Life of Wesley, and the Rise and Progress of Methodism.** 5*s*.

—— **Robert Southey.** The Story of his Life written in his Letters. With an Introduction. Edited by John Dennis. 3*s*. 6*d*.

SOZOMEN'S Ecclesiastical History. Comprising a History of the Church from A.D. 324–440. Translated from the Greek. Together with the ECCLESIASTICAL HISTORY OF PHILOSTORGIUS, as epitomised by Photius. Translated from the Greek by Rev. E. Walford, M.A. 5*s*.

SPINOZA'S Chief Works. Translated, with Introduction, by R.H.M. Elwes. 2 vols. 5*s.* each.

STANLEY'S Classified Synopsis of the Principal Painters of the Dutch and Flemish Schools. By George Stanley. 5*s.*

STARLING'S (Miss) Noble Deeds of Women; or, Examples of Female Courage, Fortitude, and Virtue. With 14 Steel Engravings. 5*s.*

STAUNTON'S Chess-Player's Handbook. A Popular and Scientific Introduction to the Game. With numerous Diagrams. 5*s.*

—— **Chess Praxis.** A Supplement to the Chess-player's Handbook. Containing the most important modern improvements in the Openings; Code of Chess Laws; and a Selection of Morphy's Games. Annotated. 5*s.*

—— **Chess-player's Companion.** Comprising a Treatise on Odds, Collection of Match Games, and a Selection of Original Problems. 5*s.*

—— **Chess Tournament of 1851.** A Collection of Games played at this celebrated assemblage. With Introduction and Notes. 5*s.*

STOCKHARDT'S Experimental Chemistry. A Handbook for the Study of the Science by simple experiments. Edited by C. W. Heaton, F.C.S. With numerous Woodcuts. New Edition, revised throughout. 5*s.*

STRABO'S Geography. Translated by W. Falconer, M.A., and H. C. Hamilton. 3 vols. 5*s.* each.

STRICKLAND'S (Agnes) Lives of the Queens of England, from the Norman Conquest. Revised Edition. With 6 Portraits. 6 vols. 5*s.* each.

STRICKLAND'S Life of Mary Queen of Scots. 2 vols. 5*s.* each.

—— **Lives of the Tudor and Stuart Princesses.** With Portraits. 5*s.*

STUART and REVETT'S Antiquities of Athens, and other Monuments of Greece; to which is added, a Glossary of Terms used in Grecian Architecture. With 71 Plates engraved on Steel, and numerous Woodcut Capitals. 5*s.*

SUETONIUS' Lives of the Twelve Cæsars and Lives of the Grammarians. The translation of Thomson, revised by T. Forester. 5*s.*

SWIFT'S Prose Works. Edited by Temple Scott. With a Biographical Introduction by the Right Hon. W. E. H. Lecky, M.P. With Portraits and Facsimiles. 12 vols. 3*s.* 6*d.* each.
[*Vols. I.-VI. & VIII.-X. ready.*

I.—A Tale of a Tub, The Battle of the Books, and other early works. Edited by Temple Scott. With a Biographical Introduction by the Right Hon. W. E. H. Lecky, M.P.

II.—The Journal to Stella. Edited by Frederick Ryland, M.A. With 2 Portraits of Stella, and a Facsimile of one of the Letters.

III. & IV.—Writings on Religion and the Church. Edited by Temple Scott.

V.—Historical and Political Tracts (English). Edited by Temple Scott.

VI.—The Drapier's Letters. With facsimiles of Wood's Coinage, &c. Edited by Temple Scott.

VII.—Historical and Political Tracts (Irish).
[*In the press.*

SWIFT'S PROSE WORKS *continued.*

VIII.—Gulliver's Travels. Edited by G. R. Dennis. With Portrait and Maps.

IX.—Contributions to the 'Examiner,' 'Tatler,' 'Spectator,' &c. Edited by Temple Scott.

X.—Historical Writings. Edited by Temple Scott.

XI.—Literary Essays. [*In preparation.*

XII.—Index and Bibliography. [*In preparation.*

STOWE (Mrs. H. B.) Uncle Tom's Cabin, or Life among the Lowly. With Introductory Remarks by Rev. J. Sherman. With 8 full-page Illustrations. 3*s.* 6*d.*

TACITUS. The Works of. Literally translated. 2 vols. 5*s.* each.

TALES OF THE GENII; or, the Delightful Lessons of Horam, the Son of Asmar. Translated from the Persian by Sir Charles Morell. Numerous Woodcuts and 12 Steel Engravings. 5*s.*

TASSO'S Jerusalem Delivered. Translated into English Spenserian Verse by J. H. Wiffen. With 8 Engravings on Steel and 24 Woodcuts by Thurston. 5*s.*

TAYLOR'S (Bishop Jeremy) Holy Living and Dying, with Prayers containing the Whole Duty of a Christian and the parts of Devotion fitted to all Occasions and furnished for all Necessities. 3*s.* 6*d.*

TEN BRINK.—*See* BRINK.

TERENCE and PHÆDRUS. Literally translated by H. T. Riley, M.A. To which is added, SMART'S METRICAL VERSION OF PHÆDRUS. 5*s.*

THEOCRITUS, BION, MOSCHUS, and TYRTÆUS. Literally translated by the Rev. J. Banks, M.A. To which are appended the Metrical Versions of Chapman. 5*s.*

THEODORET and EVAGRIUS. Histories of the Church from A.D. 332 to A.D. 427; and from A.D. 431 to A.D. 544. Translated from the Greek. 5*s.*

THIERRY'S History of the Conquest of England by the Normans; its Causes, and its Consequences in England, Scotland, Ireland, and the Continent. Translated by William Hazlitt. 2 vols. 3*s.* 6*d.* each.

THUCYDIDES. The Peloponnesian War. Literally translated by the Rev. H. Dale. 2 vols. 3*s.* 6*d.* each.

—— **An Analysis and Summary of.** With Chronological Table of Events, &c. By J. T. Wheeler. 5*s.*

THUDICHUM (J. L. W.) A Treatise on Wines: their Origin, Nature, and Varieties. With Practical Directions for Viticulture and Vinification. By J. L. W. Thudichum, M.D., F.R.C.P. (Lond.). Illustrated. 5*s.*

URE'S (Dr. A.) Cotton Manufacture of Great Britain, systematically investigated. Revised Edit. by P. L. Simmonds. With 150 original Illustrations. 2 vols. 5*s.* each.

—— **Philosophy of Manufactures.** Revised Edition, by P. L. Simmonds. With numerous Figures. Double volume. 7*s.* 6*d.*

VASARI'S Lives of the most Eminent Painters, Sculptors, and Architects. Translated by Mrs. J. Foster, with a Commentary by J. P. Richter, Ph.D. 6 vols. 3*s.* 6*d.* each.

VIRGIL. A Literal Prose Translation by A. Hamilton Bryce, LL.D., F.R.S.E. With Portrait. 3*s.* 6*d.*

VOLTAIRE'S Tales. Translated by R. B. Boswell. Vol. I., containing Bebouc, Memnon, Candide, L'Ingénu, and other Tales. 3*s*. 6*d*.

WALTON'S Complete Angler, or the Contemplative Man's Recreation, by Izaak Walton and Charles Cotton. Edited by Edward Jesse. To which is added an account of Fishing Stations, Tackle, &c., by Henry G. Bohn. With Portrait and 203 Engravings on Wood and 26 Engravings on Steel. 5*s*.

—— **Lives of Donne, Hooker, &c.** New Edition revised by A. H. Bullen, with a Memoir of Izaak Walton by Wm. Dowling. With numerous Illustrations. 5*s*.

WELLINGTON, Life of. By 'An Old Soldier.' From the materials of Maxwell. With Index and 18 Steel Engravings. 5*s*.

—— **Victories of.** *See* MAXWELL.

WERNER'S Templars in Cyprus. Translated by E. A. M. Lewis. 3*s*. 6*d*.

WESTROPP (H. M.) A Handbook of Archæology, Egyptian, Greek, Etruscan, Roman. By H. M. Westropp. 2nd Edition, revised. With very numerous Illustrations. 5*s*.

WHITE'S Natural History of Selborne, with Observations on various Parts of Nature, and the Naturalists' Calendar. With Notes by Sir William Jardine. Edited by Edward Jesse. With 40 Portraits and coloured Plates. 5*s*.

WHEATLEY'S A Rational Illustration of the Book of Common Prayer. 3*s*. 6*d*.

WHEELER'S Noted Names of Fiction, Dictionary of. Including also Familiar Pseudonyms, Surnames bestowed on Eminent Men, and Analogous Popular Appellations often referred to in Literature and Conversation. By W. A. Wheeler, M.A. 5*s*.

WIESELER'S Chronological Synopsis of the Four Gospels. Translated by the Rev. Canon Venables. 3*s*. 6*d*.

WILLIAM of MALMESBURY'S Chronicle of the Kings of England, from the Earliest Period to the Reign of King Stephen. Translated by the Rev. J. Sharpe. Edited by J. A. Giles, D.C.L. 5*s*.

XENOPHON'S Works. Translated by the Rev. J. S. Watson, M.A., and the Rev. H. Dale. In 3 vols. 5*s*. each.

YOUNG (Arthur). Travels in France during the years 1787, 1788, and 1789. Edited by M. Betham Edwards. 3*s*. 6*d*.

—— **Tour in Ireland,** with General Observations on the state of the country during the years 1776–79. Edited by A. W. Hutton. With Complete Bibliography by J. P. Anderson, and Map. 2 vols. 3*s*. 6*d*. each.

YULE-TIDE STORIES. A Collection of Scandinavian and North-German Popular Tales and Traditions, from the Swedish, Danish, and German. Edited by B. Thorpe. 5*s*.

NEW AND FORTHCOMING VOLUMES OF

BOHN'S LIBRARIES.

THE PROSE WORKS OF JONATHAN SWIFT. Edited by Temple Scott. With an Introduction by the Right Hon. W. E. H. Lecky, M.P. In 11 volumes, 3*s.* 6*d.* each.

Vol. I.—'A Tale of a Tub,' 'The Battle of the Books,' and other early works. Edited by Temple Scott. With Introduction by the Right Hon. W. E. H. Lecky, M.P. Portrait and Facsimiles.

Vol. II.—'The Journal to Stella.' Edited by F. Ryland, M.A. With a Facsimile Letter and two Portraits of Stella.

Vols. III. and IV.—Writings on Religion and the Church. Edited by Temple Scott. With portraits and facsimiles of title pages.

Vol. V.—Historical and Political Tracts (English). Edited by Temple Scott. With Portrait and Facsimiles.

Vol. VI.—The Drapier's Letters. Edited by Temple Scott. With Portrait. Reproductions of Wood's Coinage and facsimiles of title pages.

Vol. VIII.—Gulliver's Travels. Edited by G. R. Dennis. With the original Maps and Illustrations.

Vol. IX.—Contributions to 'The Tatler,' 'The Examiner,' 'The Spectator,' and 'The Intelligencer.' Edited by Temple Scott. With Portrait.

Vol. X.—Historical Writings. Edited by Temple Scott. With Portrait.

PRESCOTT'S CONQUEST OF MEXICO. Copyright edition, with the author's latest corrections and additions, and the notes of John Foster Kirk. With an introduction by George Parker Winship. 3 vols. 3*s.* 6*d.* each.

PRESCOTT'S CONQUEST OF PERU. Copyright edition. Edited by John Foster Kirk. 2 vols. 3*s.* 6*d.* each.

PRESCOTT'S FERDINAND AND ISABELLA. Copyright edition. Edited by John Foster Kirk. 3 vols. 3*s.* 6*d.* each.

GRAY'S LETTERS. Edited by Duncan C. Tovey, M.A., Editor of 'Gray and his Friends,' &c., late Clark Lecturer at Trinity College, Cambridge. Vols. I. and II. 3*s.* 6*d.* each.

CICERO'S LETTERS. The whole extant Correspondence. Translated by Evelyn S. Shuckburgh, M.A. In 4 vols. 5*s.* each.

50,000. S. & S. 11.04.